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AERODYNAMIC AND ACOUSTIC INVESTIGATION OF INVERTED
VELOCITY PROFILE COANNULAR EXHAUST NOZZLE MODELS AND
DEVELOPMENT OF AERODYNAMIC AND ACOUSTIC PREDICTION PROCEDURES

COMPREHENSIVE DATA REPORT
Volume I

By

R. S. Larson, D. P. Nelson and B. S. Stevens

Commercial Products Division
Pratt & Whitney Aircraft Group
United Technologies Corporation

(NASA-CR-159515) AERODYNAMIC AND ACOUSTIC
INVESTIGATION OF INVERTED VELOCITY PROFILE
COANNULAR EXHAUST NOZZLE MODELS AND
DEVELOPMENT OF AERODYNAMIC AND ACOUSTIC
PREDICTION (Pratt and Whitney Aircraft

N79-30185

G3/07 Unclassified
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Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Lewis Research Center
Under
Contract NAS3-20061



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LIST OF SYMBOLS

A_T	Total Nozzle Area
C_a	Ambient Speed of Sound
C_D	Discharge Coefficient
C_T	Thrust Coefficient
HFSPL	High Frequency Sound Pressure Level
LFSPL	Low Frequency Sound Pressure Level
P_a	Ambient Pressure
PR	Pressure Ratio
P_T	Total Pressure
R	Radius
R_F	Fan Stream Radius Ratio
R_p	Primary Stream Radius Ratio
T_F	Fan Stream Temperature
T_p	Primary Stream Temperature
T_T	Total Temperature
V	Velocity
V_F	Fan Stream Velocity
V_i	Initial Region Characteristic Velocity
V_m	Merged Region Characteristic Velocity
V_o	Flight Velocity
V_p	Primary Stream Velocity
M_i	Initial Region Mach Number
M_p	Merged Region Mach Number
h	Relative Velocity Exponent
Greek Letter	
θ	Angle measured with respect to the nozzle exit plane
θ_m	Angle measured with respect to the merged region location
Subscripts	
corr	Corrected for temperature by use of the SAE density exponent

I. SUMMARY

This report documents the work performed during the Static Aero/Acoustic Configuration Study. This report is presented in two volumes to facilitate its use. Volume I contains the graphical presentation of acoustic and aero data generated in this program. Volume II contains the tabular acoustic and aero data generated in the program. The acoustic data are presented as measured, corrected to a "theoretical day", and scaled to full engine size.

A complete description of the test hardware and test facilities is contained in the Final Report, NASA CR-3168. Significant test results, conclusions, and recommendations are also included in the Final Report.

2. INTRODUCTION

The acoustic and aerodynamic data measured during the program are presented in this volume in graphical form. The content of each section is described below.

Acoustic Plots

The graphical correlations and plots used in the acoustic data analysis are contained in this section. Included are PNL directivity curves for all operating conditions, SPL spectra for all operating conditions at angles of 90 degrees, 120 degrees, and 150 degrees, and data correlation curves. The test facility and acoustic instrumentation are described in the Final Report, CR-3168.

PNL and OASPL data are contained in Volume I of the Comprehensive Data Report.

- Section A PNL directivity plots were made from data scaled by a factor of 12 to predict the noise from a full scale engine and extrapolated to a sideline distance of 2128 ft. The data were extrapolated on a Standard FAA day with a relative humidity of 70 percent and a temperature of 77°F.
- Section B SPL spectral plots were made from the scaled data which were extrapolated to "Standard Day" and to a 150 ft radius. Plots were made at angles of 90 degrees, 120 degrees, and 150 degrees. Each plot contains data from all configurations tested at a given operating condition.
- Section C Acoustic data correlations include correlations of $LFSPL_{corr}$ versus $\log V_m/C_a$, for the acoustic data at angles from 60 degrees to 160 degrees; correlations of $HFSPL_{corr}$ versus fan and primary radius ratio; and correlations of $LFSPL_{corr}$ and $HFSPL_{corr}$ with difference between merged region and flight velocities and initial region velocity respectively.

Aerodynamic Plots

This section presents the nozzle exhaust velocity and temperature profiles and nozzle thrust and flow performance. The performance facility and instrumentation are described in the Final Report.

- Section D The development of nozzle exhaust velocity and temperature profiles downstream of the nozzle exit is presented in this section. The profiles of each configuration surveyed are compared at the five axial traverse locations.
- Section E This section presents measured nozzle thrust and discharge coefficients (C_T and C_D) at various nozzle pressure ratios for all the configurations tested.

3. INDEX TO DATA CURVES

The acoustic and aerodynamic data plots are presented by configuration letter which are identified below. A detailed definition of the model geometry may be found in Final Report, CR-3168.

Configuration	Fan	Radius Ratio
		Primary
A	0.69	—
B	0.75	—
C	0.83	—
D	0.75	0.60
E	0.83	0.81

Section A -- Scaled Engine Noise Directivity

Each PNL directivity plot is identified by configuration and engine condition number. The curves are arranged by sequential run number for each configuration from A to E.

To relate the run number to the various nominal nozzle test conditions a test matrix is provided on page 5. To use the matrix, assume it is necessary to find the run number for Configuration A tested at a fan pressure ratio of 2.5, 800°F and a primary pressure ratio of 1.53, 1000°F; the matrix shows the run number is 8303.

Section B -- Comparison of Scaled SPL Spectra

The full scaled data were scaled by a factor of 12. The coannular models had an equivalent diameter of 5 inches and the scaled data had an equivalent diameter of 60 inches. The single stream model had an equivalent diameter of 3.2 inches and the scaled data had an equivalent diameter of 38.4 inches. The model data levels were scaled to full scale by addition of 21.6 dB (20 log 12) to the model data, and the model data frequencies were scaled to full scale by multiplying the model frequencies by a factor of 1/12.

Each spectral comparison plot is identified by condition number as defined in the acoustic test matrix. The comparisons are organized by sequential test point number.

Section C -- Acoustic Data Correlations

Data correlations are included for Configurations A, B, C, D, and E for the initial region noise component and for Configuration A for the merged region component. Overlays of the data correlations are contained in the Final Report.

Shock noise data correlations are also contained in the Final Report.

The data correlations are arranged in the following sequence:

- $LFSPL_{corr}$ versus $\log V_m/C_a$
- $HFSPL_{corr}$ versus $\log V_i/C_a$
- $HFSPL_{corr}$ versus fan and primary radius ratio
- $LFSPL_{corr}$ versus $\log V_m/(V_m - V_o)$
- $HFSPL_{corr}$ versus $\log V_i/(V_i - V_o)$

All data correlations were based on model scale data.

Section D – Nozzle Exhaust Velocity and Temperature Profiles

Each velocity and temperature profile plot, obtained for selected conditions, is identified by configuration and engine condition number as defined in the acoustic test matrix. The velocity profiles are presented first, followed by the temperature profiles. Each set is organized by sequential number for each configuration.

Section E – Measured Nozzle Performance

Each nozzle performance curve is identified by configuration and test condition. The thrust coefficient curves are presented first, followed by the discharge coefficients plots. Each set is arranged in configuration sequence.

4. ACOUSTIC TEST MATRIX

Point No.	T _t °F	FAN		PRIMARY			CONFIGURATION					
		Pressure Ratio	Velocity fps	T _t °F	Pressure Ratio	Velocity fps	A	B	C	D	E	
1	800	1.3	1030	1000	1.53	1400	8301	8201	8401	8501	8601	
2	800	1.8	1500	1000	1.53	1400	8302	8202*	8402	8502*	8602	
3	800	2.5	1850	1000	1.53	1400	8303	8203	8403	8503	8603	
4	800	3.2	2050	1000	1.53	1400	8304	8204*	8404	8504*	8604	
5	1500	1.8	1880	1000	1.53	1400	8305	8205*	8405	8505*	8605	
6	1500	2.5	2320	1000	1.53	1400	8306*	8206*	8406*	8506*	8606*	
7	1500	4.1	2800	1000	1.53	1400	8307	8207	8407	8507	8607	
8	800	1.3	1030	1000	2.0	1770	8308	8208	8408	8508	8608	
9	800	1.8	1500	1000	2.0	1770	8309	8209	8409	8509	8609	
10	800	2.5	1850	1000	2.0	1770	8310	8210	8410	8510	8610	
11	800	3.2	2050	1000	2.0	1770	8311	8211*	8411	8511*	8611	
12	1500	1.8	1880	1000	2.0	1770	8312	8212	8412	8512	8612	
13	1500	2.5	2320	1000	2.0	1770	8313	8213	8413	8513	8613	
14	1500	4.1	2800	1000	2.0	1770	8314	8214	8414	8514	8614	
15 ¹	No	Fan	Flow	800	1.3	1030		8215				
16	No	Fan	Flow	800	1.8	1500		8216				
17	No	Fan	Flow	800	2.5	1850		8217				
18	No	Fan	Flow	800	3.2	2050		8218				
19	800	1.3	1030	No	Primary	Flow		8219		8519		
20	800	1.8	1500	No	Primary	Flow		8220		8520		
21	800	2.5	1850	No	Primary	Flow		8221		8521		
22	800	3.2	2050	No	Primary	Flow		8222*		8522*		
23	1500	1.8	1880	No	Primary	Flow		8223		8523		
24	1500	2.5	2320	No	Primary	Flow		8224		8524		
25	1500	4.1	2800	No	Primary	Flow		8225		8525		
26 ¹	No	Fan	Flow	800	1.3	1030					8626	
27	No	Fan	Flow	800	1.8	1500					8627	
28	No	Fan	Flow	800	2.5	1850					8628	
29	No	Fan	Flow	800	3.2	2050					8629*	
30	No	Fan	Flow	1500	1.8	1880					8630	
31	No	Fan	Flow	1500	2.5	2320					8631	
32	No	Fan	Flow	1500	4.1	2800					8632	

*Traverse Data also were obtained

¹ The fan cowl was removed when testing with primary flow alone

112 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8301

PERCEIVED NOISE LEVEL PNL

110
108
106
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82
80
78ORIGINAL PAGE IS
OF POOR QUALITY

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8302

PERCEIVED NOISE LEVEL

120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20083F TAPE P7309 NASA VSCE (NAS3-2006) CONFIG. A

15.2049

ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8303

PERCEIVED NOISE LEVEL - PNL

124
120
118
116
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20083F TAPE P7309 NASA VSCE (NAS3-20061) CONFIG. A

15.2049

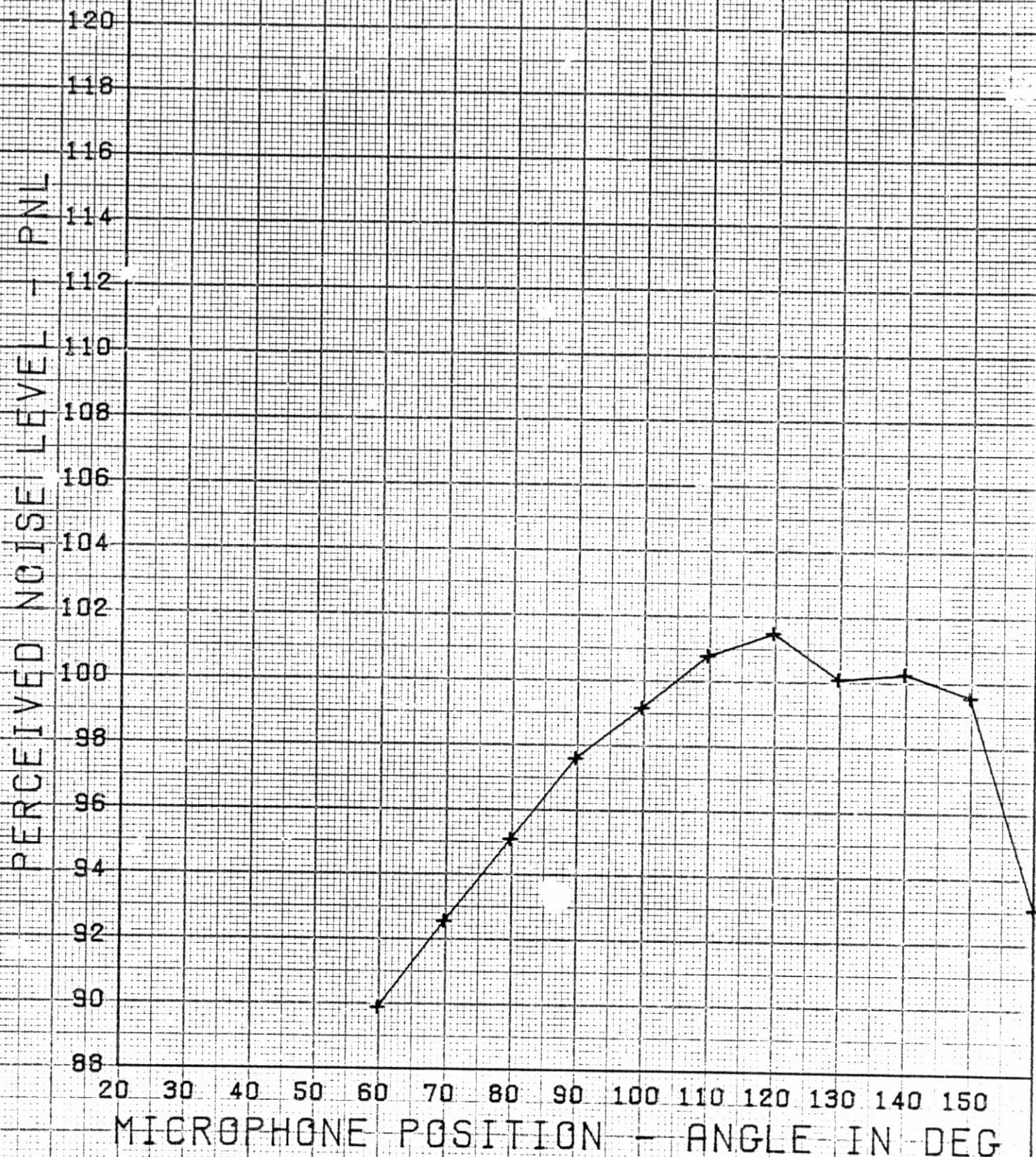
124 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8304



20063F TAPE P7308 NASA VSCE (NAS3-20061) CONFIG. A

15.2049

122 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8305



20083F TAPE P7309 NASA VSCE (NAS3-20061) CONFIG. A

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8306

PERCEIVED NOISE LEVEL PNL

122
120
118
116
114
112
110
108
106
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102
100
98
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94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20063F TAPE P7308 NASA VSCE [NASA-20061] CONFIG. 9

15.2049

124 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8307



Z0083F TAPE P7308 NASA YSC (NAS3-20061) CONFIG. A

15.2049

ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8308

PERCEIVED NOISE LEVEL - PNL

118
116
114
112
110
108
106
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102
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90
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86
84

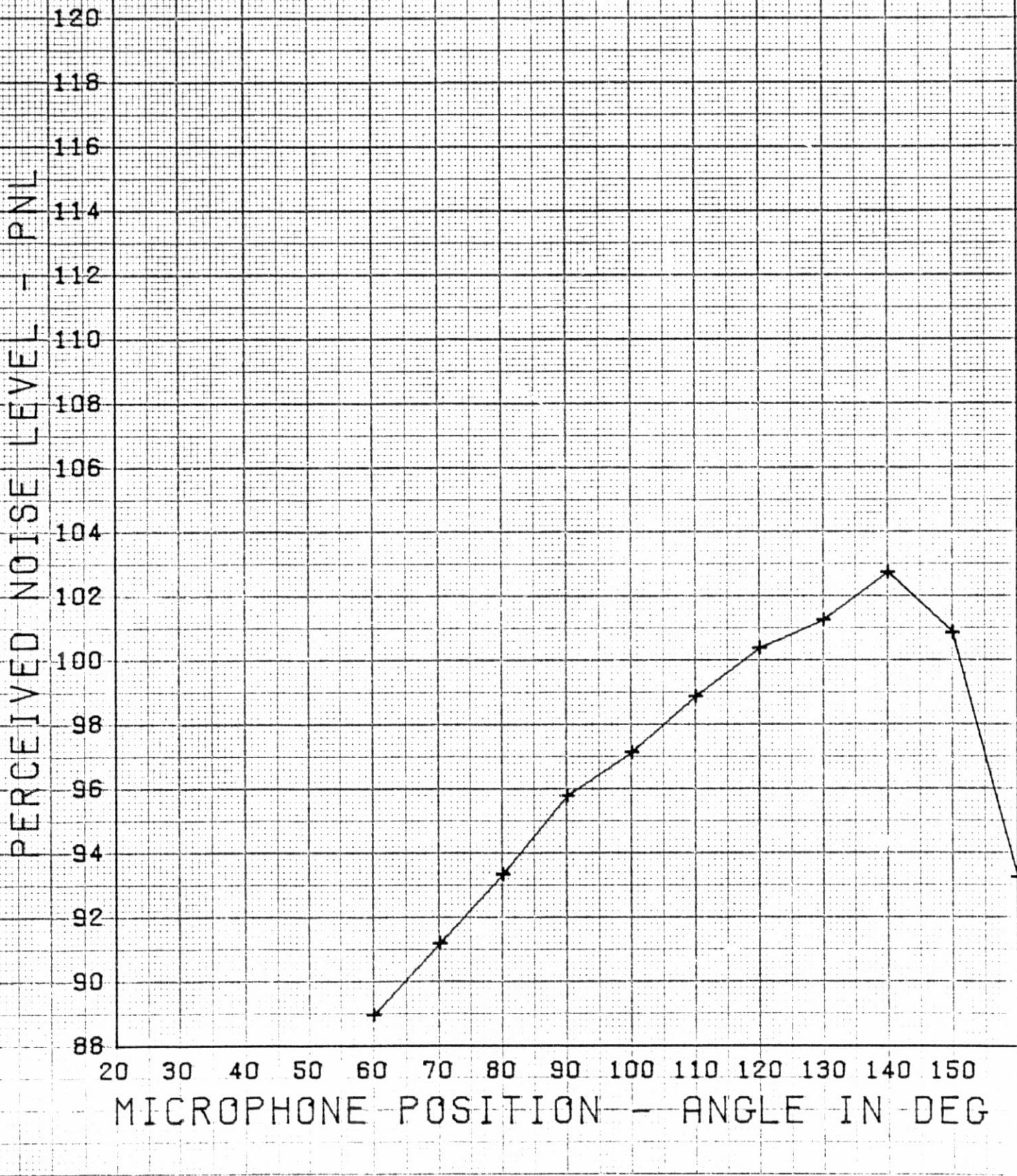
20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

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15.2049

122 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8309



20083F TAPE P7302 NASA VSCE (NAS3-2006) CONFIG. A

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8310

PERCEIVED NOISE LEVEL - PNL

122
120
118
116
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112
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100
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96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

124

ALTITUDE = 0

2128 FT SIDELINE

ENGINE CONDITION = 8311

122

120

118

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PERCEIVED NOISE LEVEL - PNL

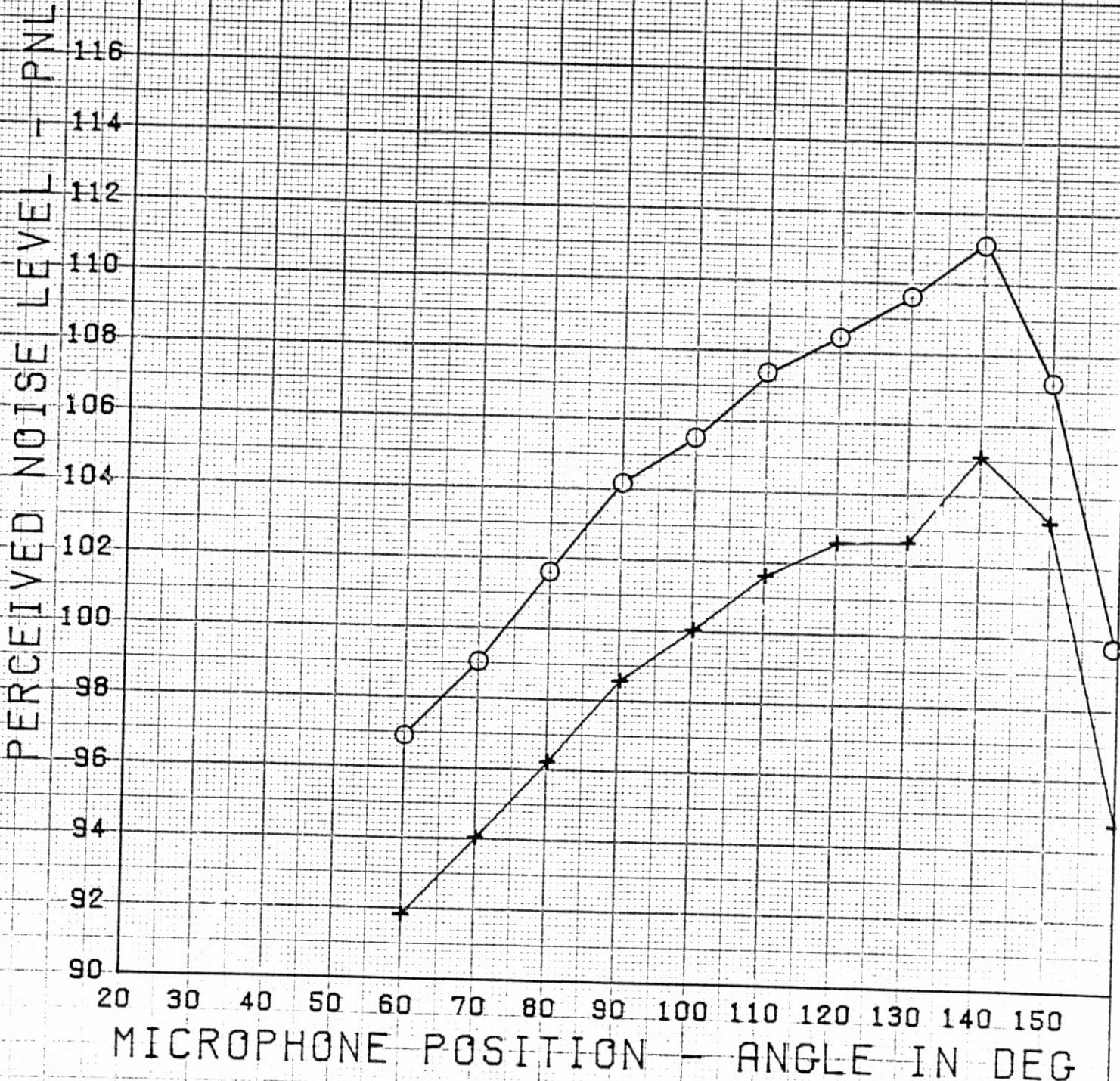
20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20083F TAPE P7308 NASA VSCE (NAS3-20061) CONFIG. A

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = +8312
122 ○ 8313
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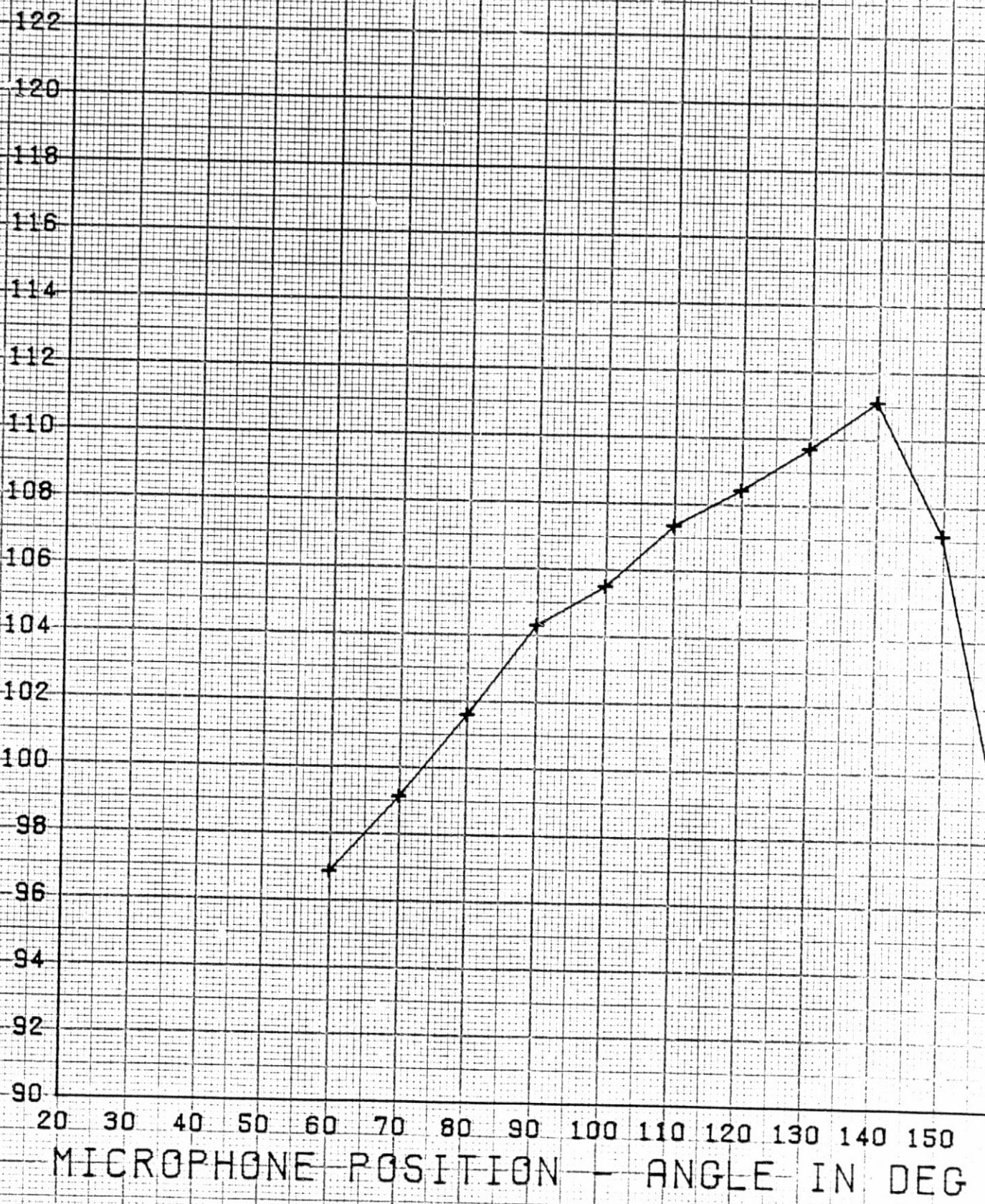


20083F TAPE P7308 NASA VSCE (NAS3-20061) CONFIG. A

15.2049

124 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8913

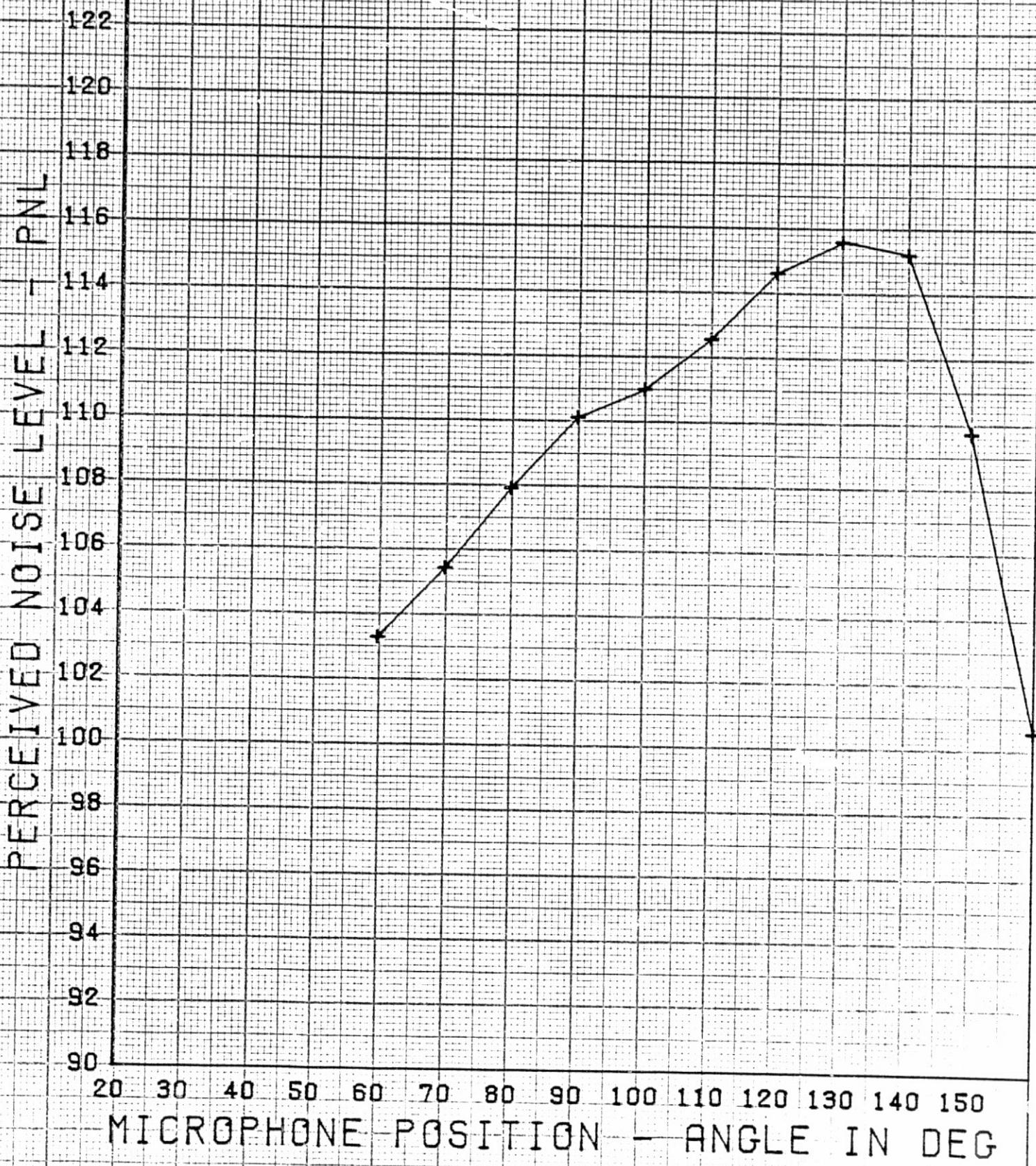
PERCEIVED NOISE LEVEL PNL



20083F TAPE P7308 NASA VSCE (NAS3-2006) CONFIG. A

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8314



MICROPHONE POSITION — ANGLE IN DEG

20082F TAPE P7300 NASA VSCE (NAS3-20061) CONFIG. B

15.2049

1-12 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8201

PERCEIVED NOISE LEVEL - PNL

112
110
108
106
104
102
100
98
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84
82
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78

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20082F TAPE P7300 NASA VSCE [NFS3-20061] CONFIG. B

15.2049

118 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8202

PERCEIVED NOISE LEVEL PNL

118
116
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102
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20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20082F TAPE P7300 NASA VSCE (NAS3-20061) CONFIG. B

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 6203

PNL

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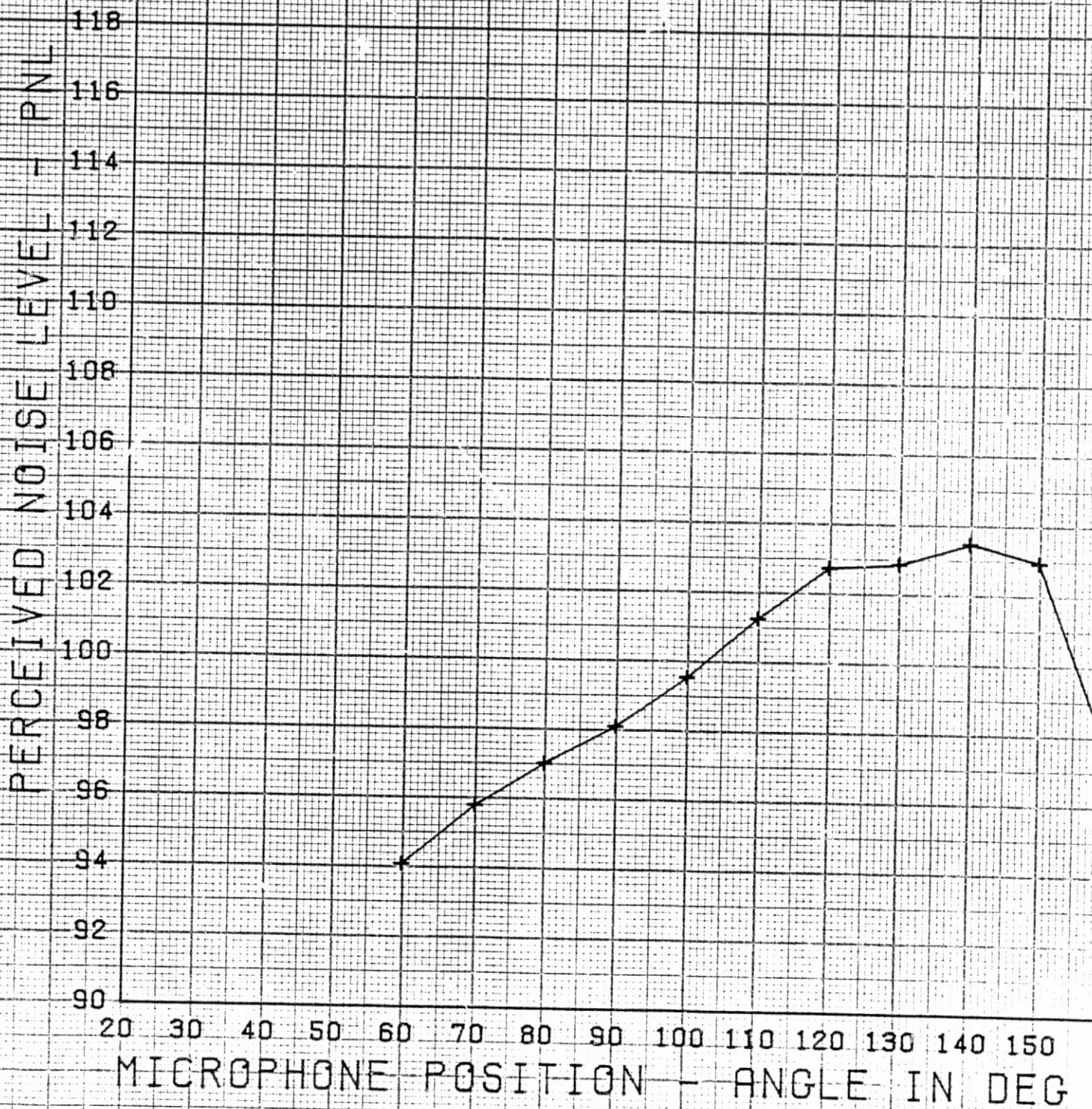
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20062F TAPE P7300 NASA VSCE (NAS3-20061) CONFIG. B

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8204

PERCEIVED NOISE LEVEL PNL

122
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20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20082F TAPE P7300 NASA VSCE (NAS3-20061) CONFIG. B

15.2049

122

ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8205

120

118

116

114

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PERCEIVED NOISE LEVEL - PNL

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92

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88

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20082F TAPE P7300 NASA VSCE (NAS3-20061) CONFIG. B

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8206

15.2049



20081F TAPE P7301 NASA VSCE (NAS3-2006) CONFIG. B

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8207

PERCEIVED NOISE LEVEL PNL

122
120
118
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114
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20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20082F TAPE P7022 NASA VSCE (NAS3-20061) CONFIG. B

15.2049

118 ALTITUDE = 0 2120 FT SIDELINE
ENGINE CONDITION = 8208

PERCEIVED NOISE LEVEL - PNL

118
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20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20082F TAPE P7022 NASA VSCE (NAS3-20061) CONFIG. B

15.2049

120 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8209

PERCEIVED NOISE LEVEL - PNLL

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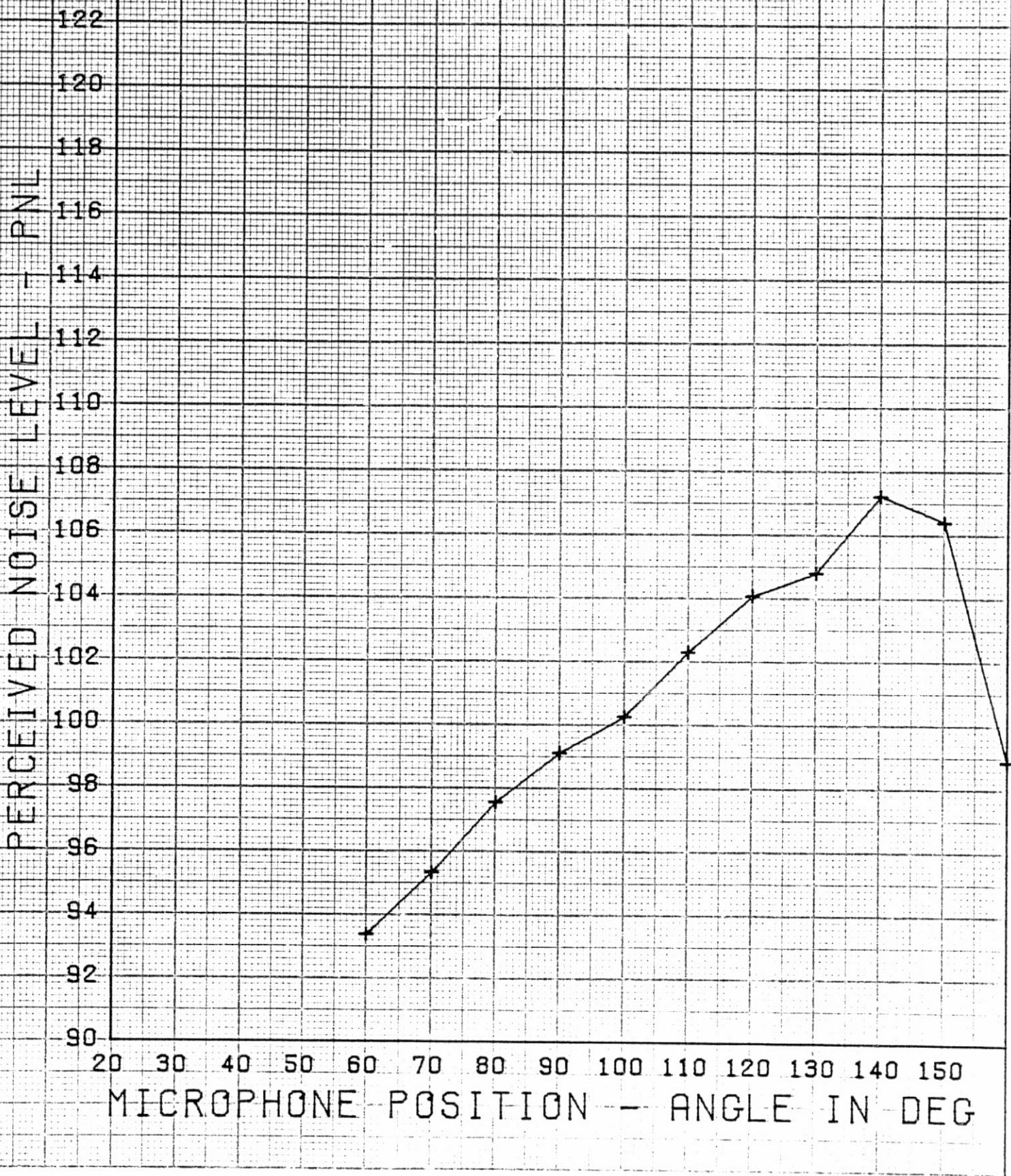
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MICROPHONE POSITION — ANGLE IN DEG

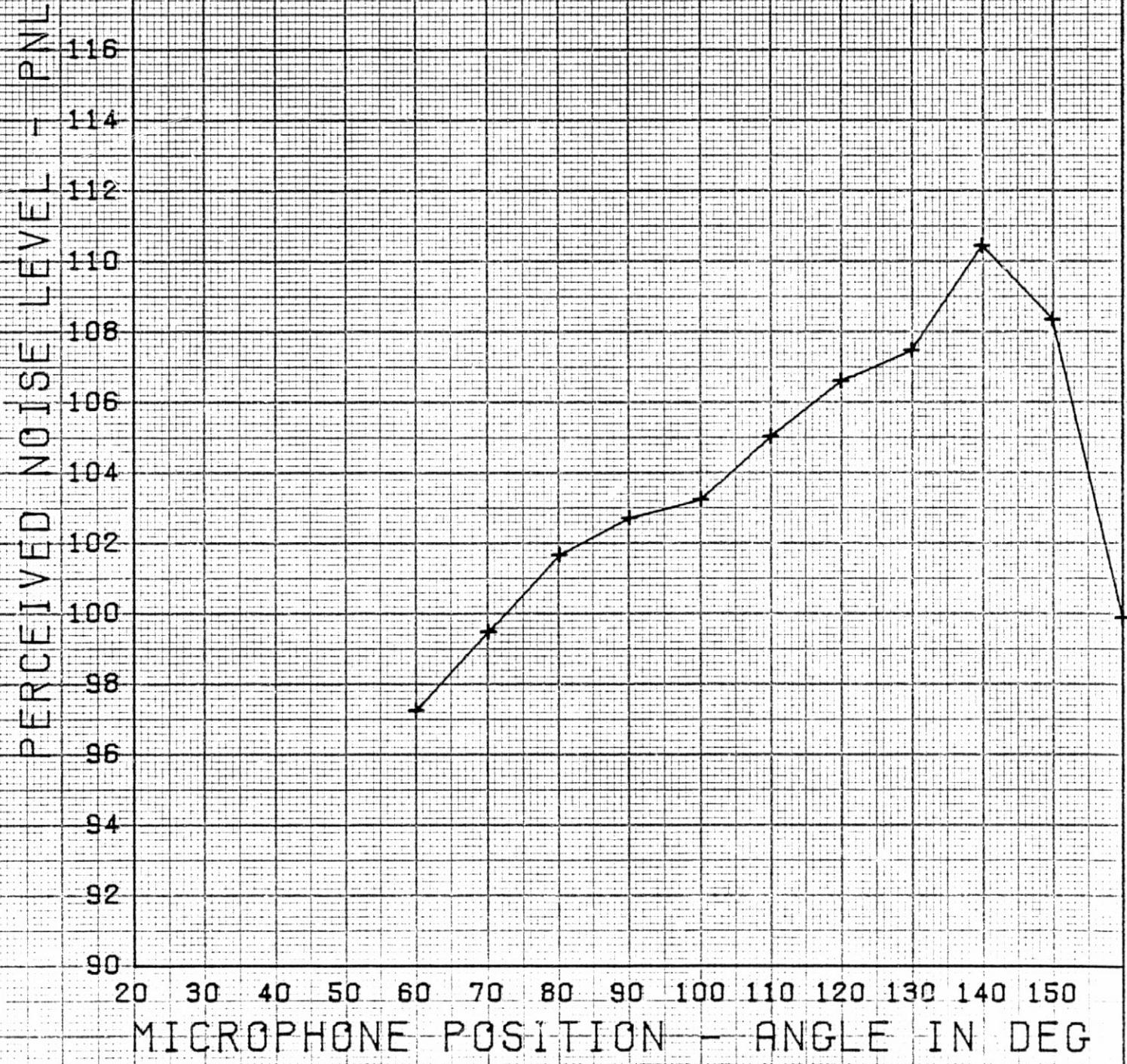
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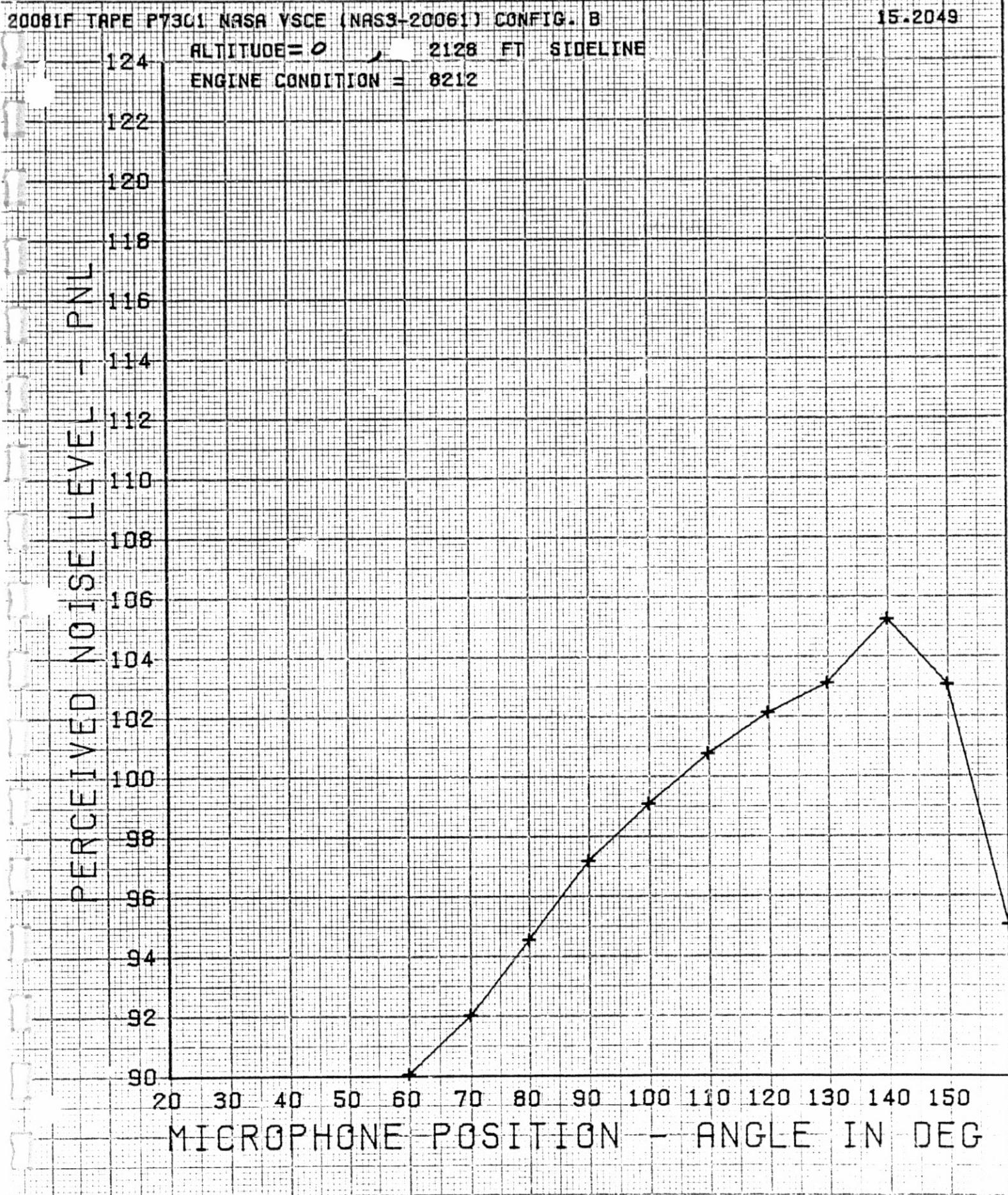
15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8210



124 ALTITUDE = 0 2128 FT SIDELINE
122 ENGINE CONDITION = 8211
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20082F TAPE P7300 NASA VSCE (NAS3-20061) CONFIG. B

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8213

PERCEIVED NOISE LEVEL - PNLL

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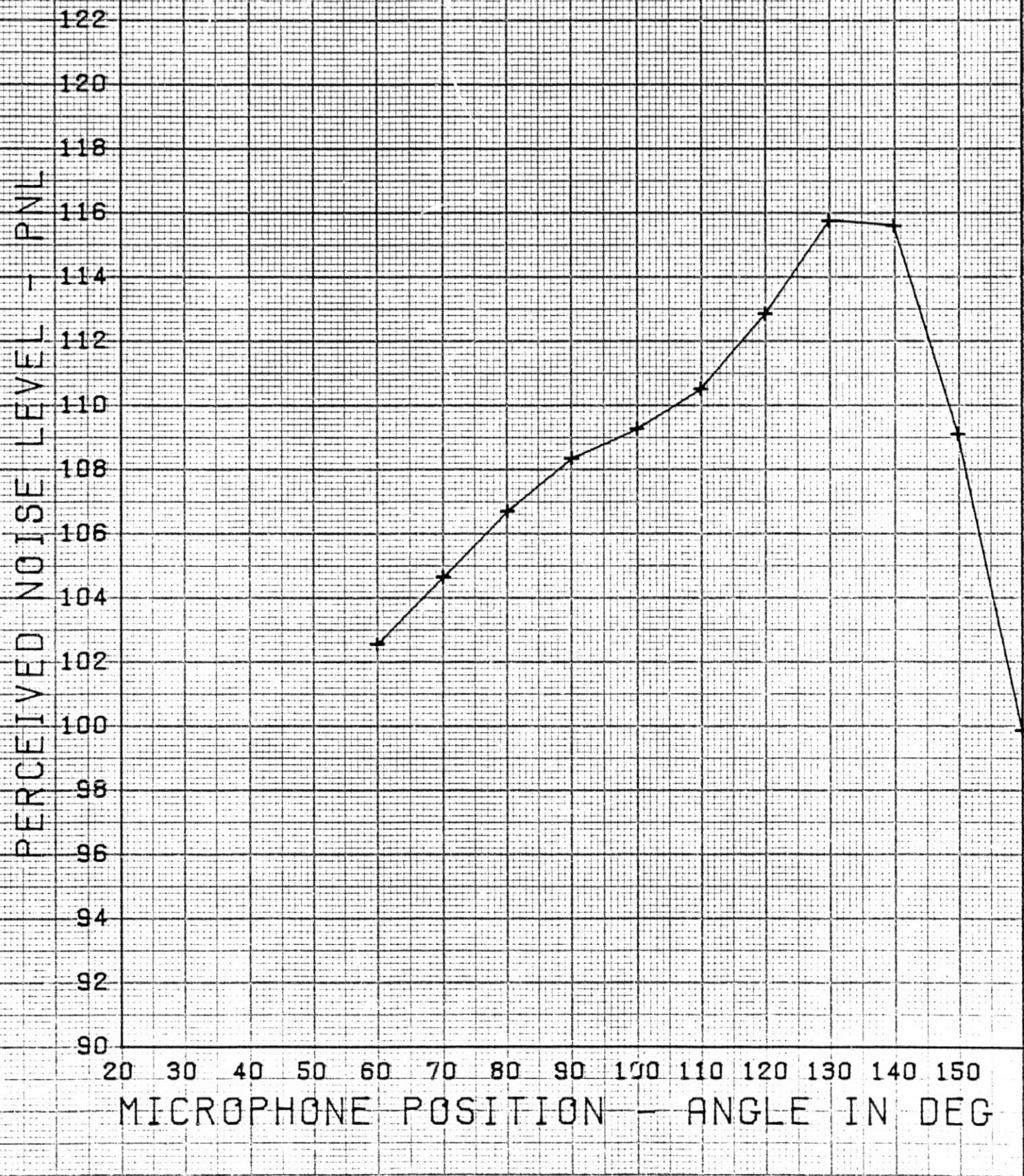
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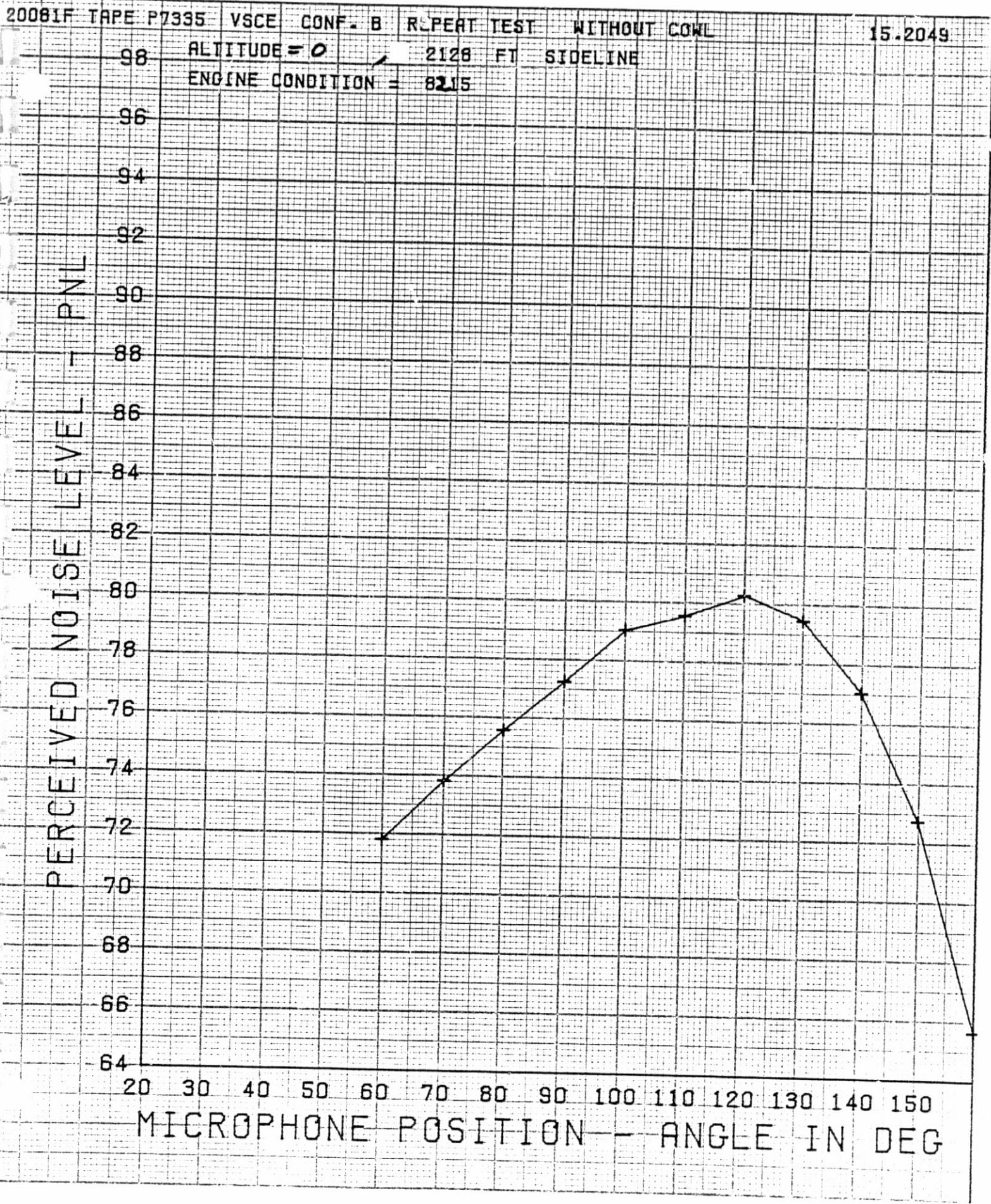
MICROPHONE POSITION - ANGLE IN DEG

20061F TAPE P7301 NASA VSCE (NAS3-2006) CONFIG. B

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8214





20081F TAPE P7335 VSCE CONF. B REPEAT TEST WITHOUT COWL

15.2049

116 ALTITUDE = 0

2128 FT SIDELINE

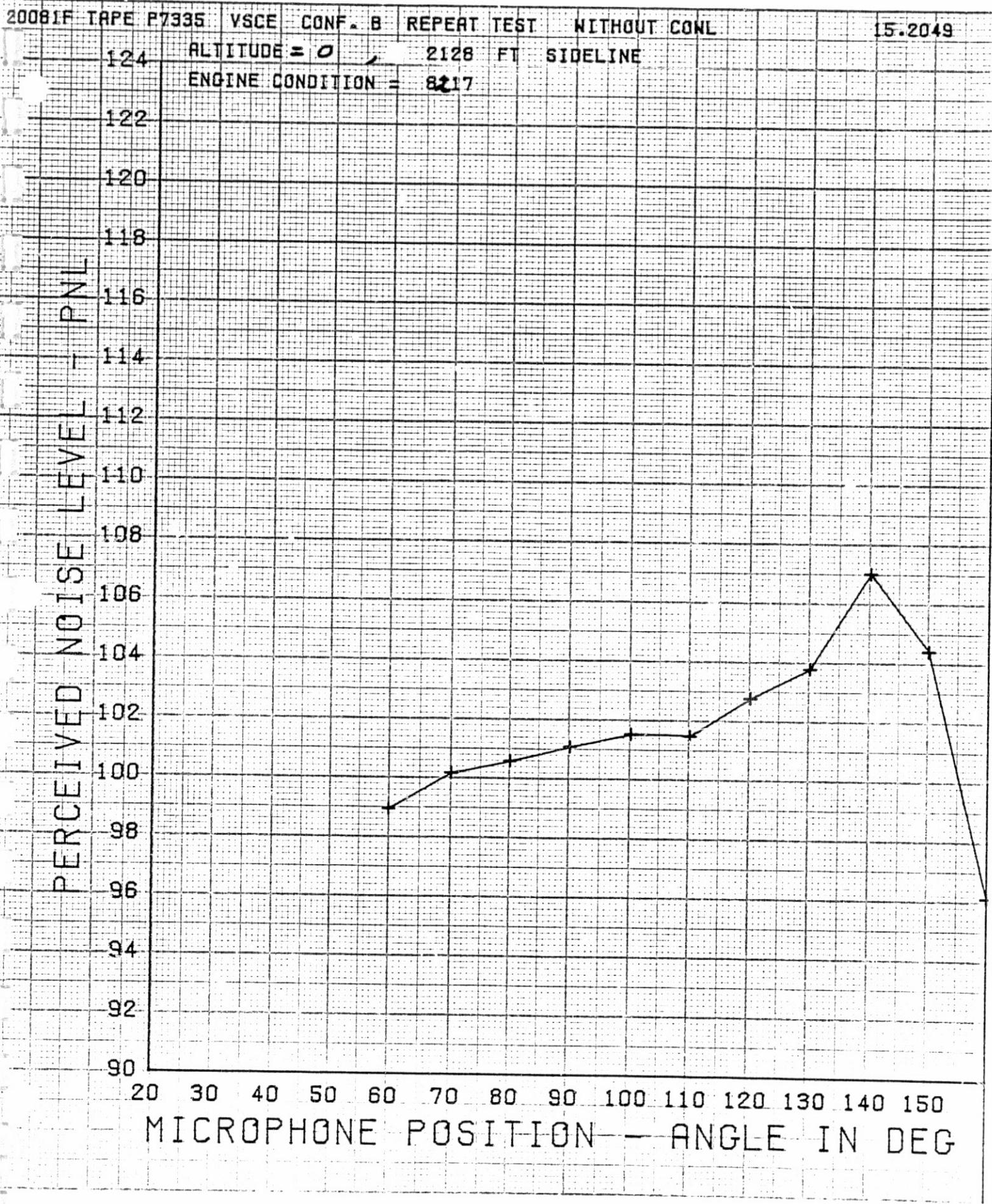
ENGINE CONDITION = 8216

RECEIVED NOISE LEVEL PNL

116
114
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20 30 40 50 60 70 80 90 100 110 120 130 140 150

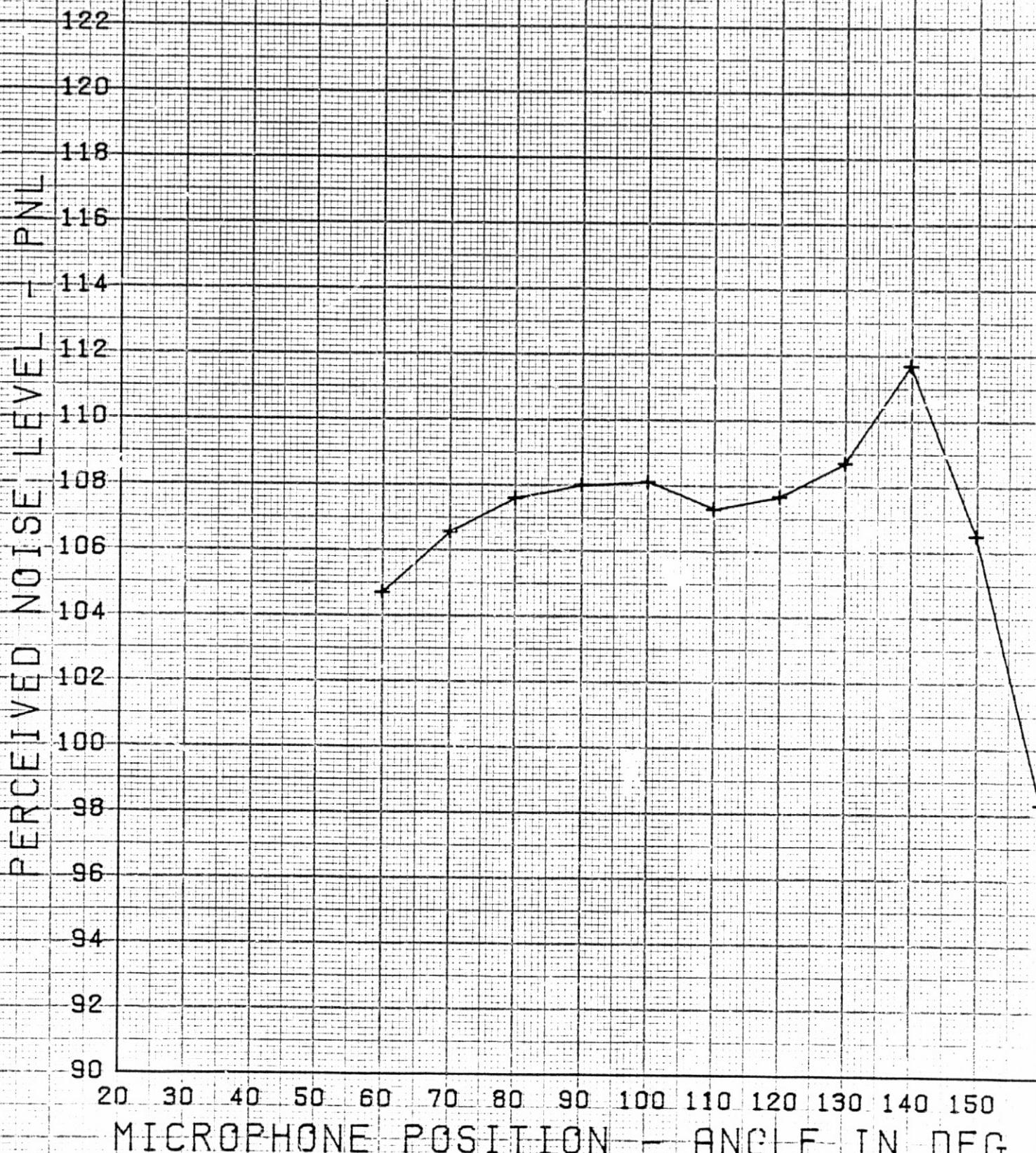
MICROPHONE POSITION ANGLE IN DEG



20081F TAPE P7335 VSCE CONF. B REPEAT TEST WITHOUT COUL

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8218



20082F TAPE P7022 NASA VSCE (NAS3-20061) CONFIG. B

15.2049

96 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8219

PERCEIVED NOISE LEVEL - PNL

96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20082F TAPE P7022 NASA VSCE (NAS3-20061) CONFIG. B

15.2049

116 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8220

PERCEIVED NOISE LEVEL - PNLL

114
112
110
108
106
104
102
100
98
96
94
92
90
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86
84
82

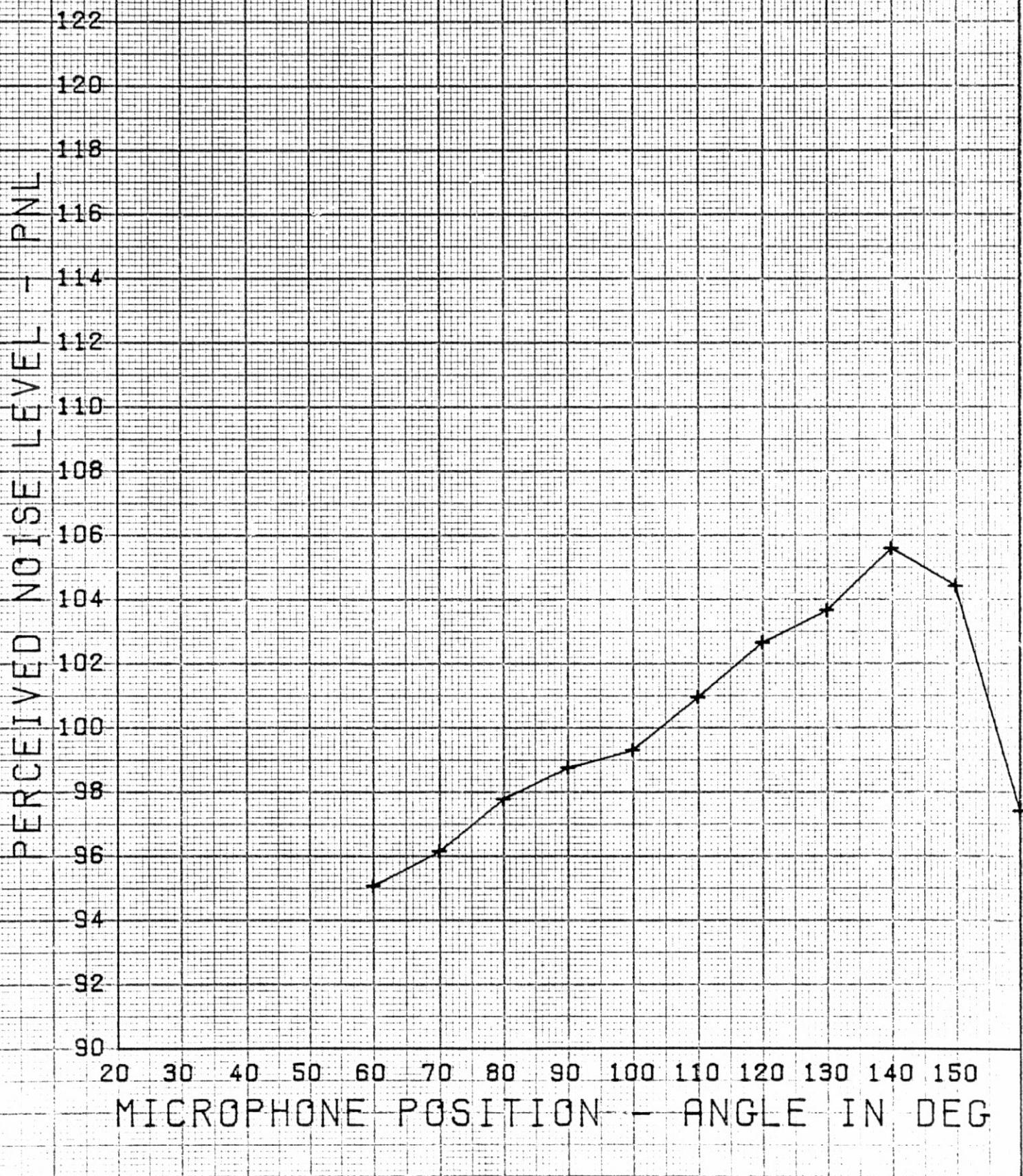
20 30 40 50 60 70 80 90 100 110 120 130 140 150

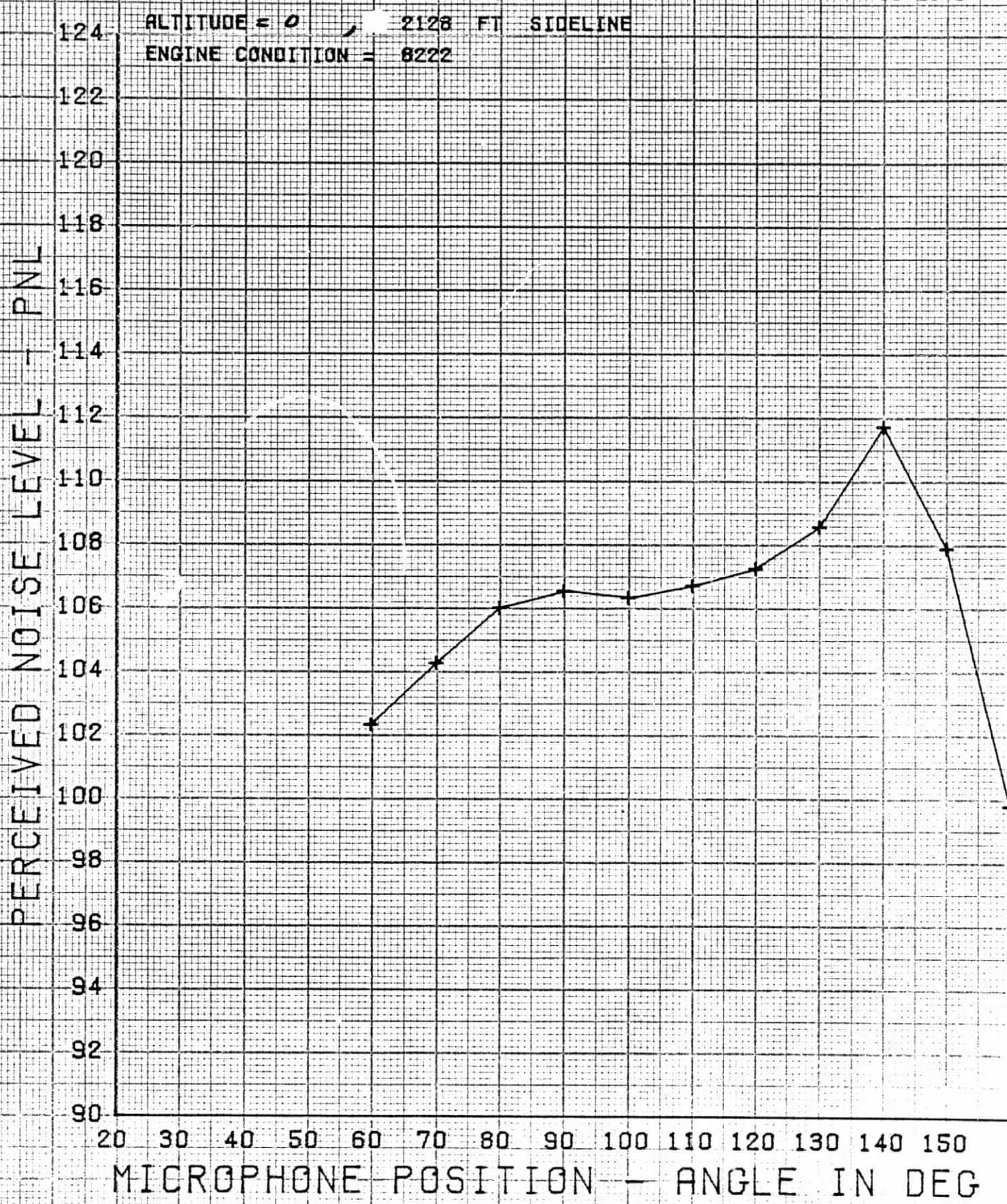
MICROPHONE POSITION - ANGLE IN DEG

0062F TAPE P7022 NASA VSCE (NAS3-20061) CONFIG. B

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8221

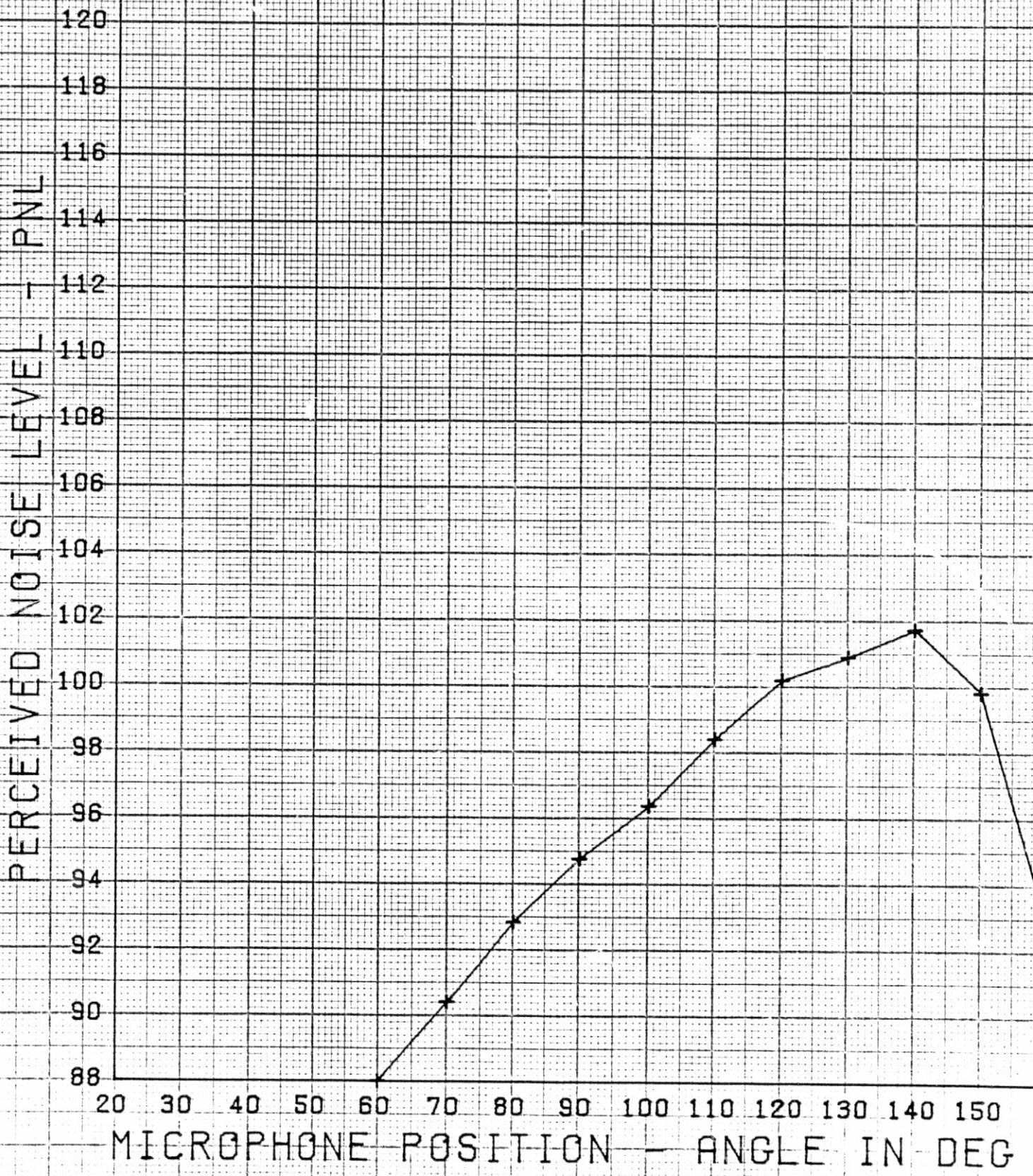


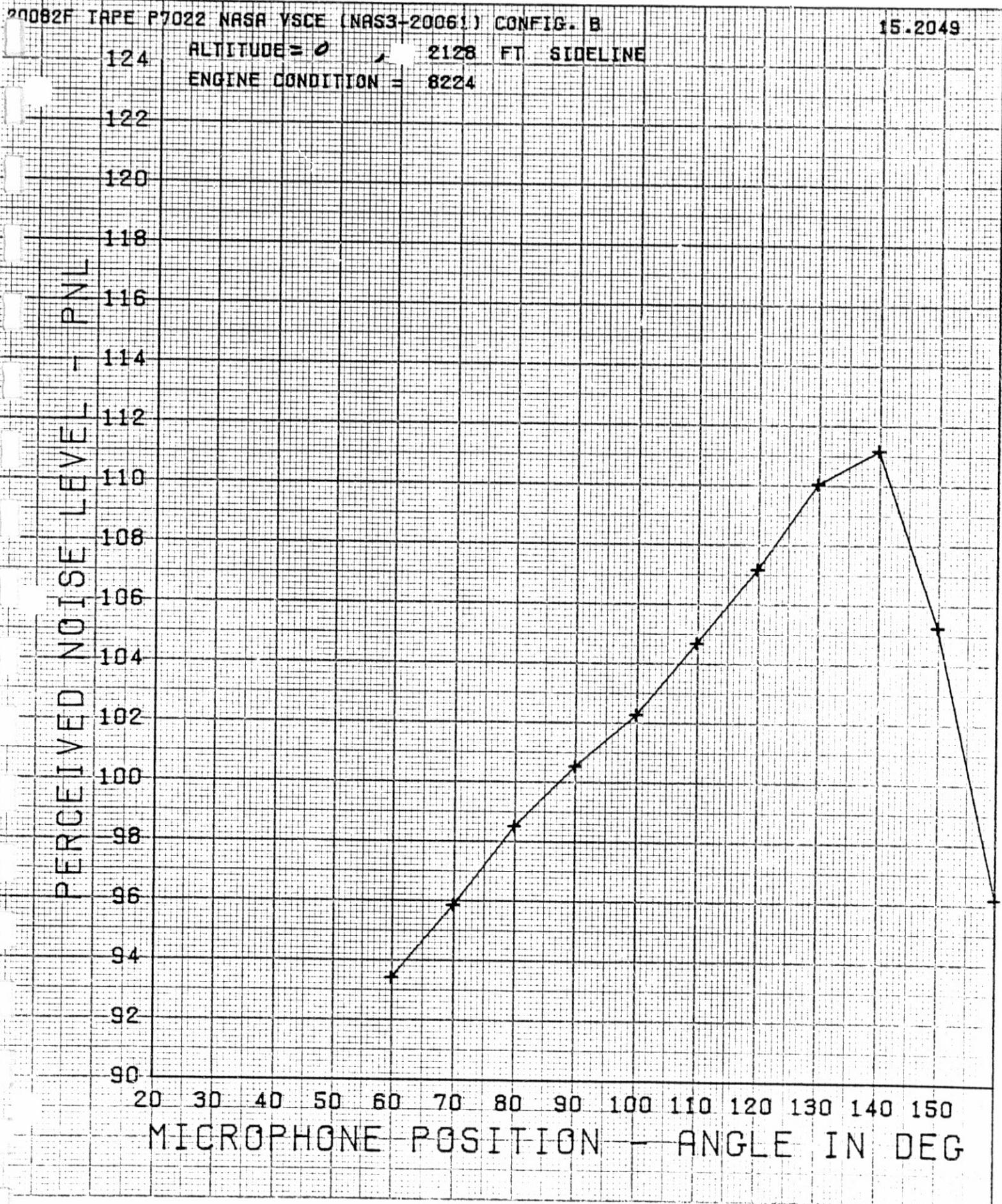


20082F TRPE P7022 NASA VSCE [NAS3-20061] CONFIG. B

15.2049

122 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8223





20082F TAPE P7022 NASA VSCE (NAS3-2006) CONFIG. B

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8225

PERCEIVED NOISE LEVEL - PNLL

124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION — ANGLE IN DEG

20084F TAPE P7333 VSCE CONF. C

15.2049

110 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8401

PERCEIVED NOISE LEVEL - PNL

110
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION ANGLE IN DEG

20084F TAPE P7333 VSCE CONF. C

15.2049

118 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8492

116

114

112

110

108

106

104

102

100

98

96

94

92

90

88

86

84

PERCEIVED NOISE LEVEL - PNL

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION ANGLE IN DEG

20084F TAPE P7333 VSCE CONF. C

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8403

PERCEIVED NOISE LEVEL - PNL.

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20084F TAPE P7333 VSCE CONF. C

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8404

PERCEIVED NOISE LEVEL - PNL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20084F TAPE P7334 VSCE CONF. C

15.2049

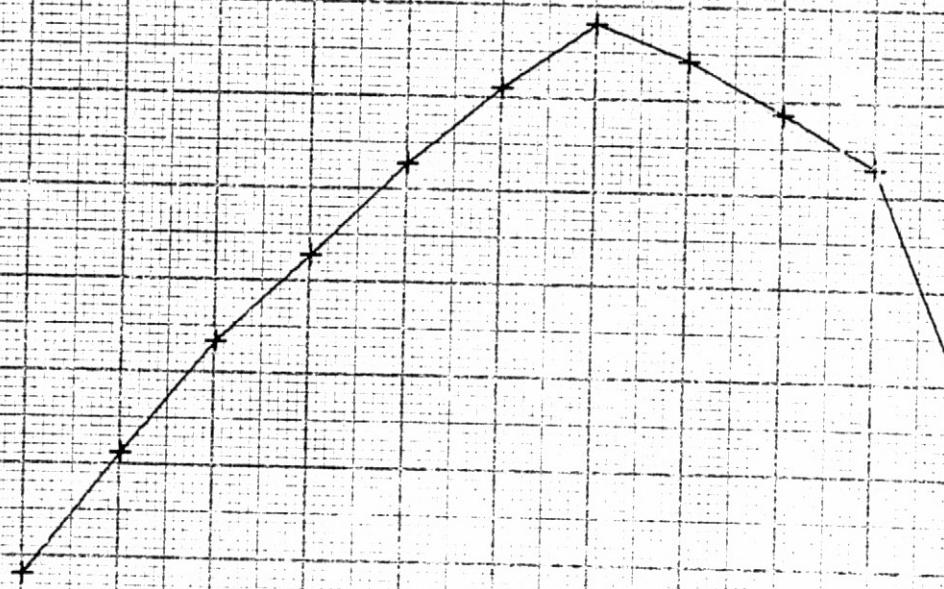
120 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8405

PERCEIVED NOISE LEVEL - PNL

120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG



20084F TAPE P7334 VSCE CONF. C

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8406

PERCEIVED NOISE LEVEL PNL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION — ANGLE IN DEG

20084F TAPE P7334 VSCE CONF. C

15.2049

124 ALTITUDE = 0

2128 FT SIDELINE

ENGINE CONDITION = 8407

PERCEIVED NOISE LEVEL - PNLL

122

120

118

116

114

112

110

108

106

104

102

100

98

96

94

92

90

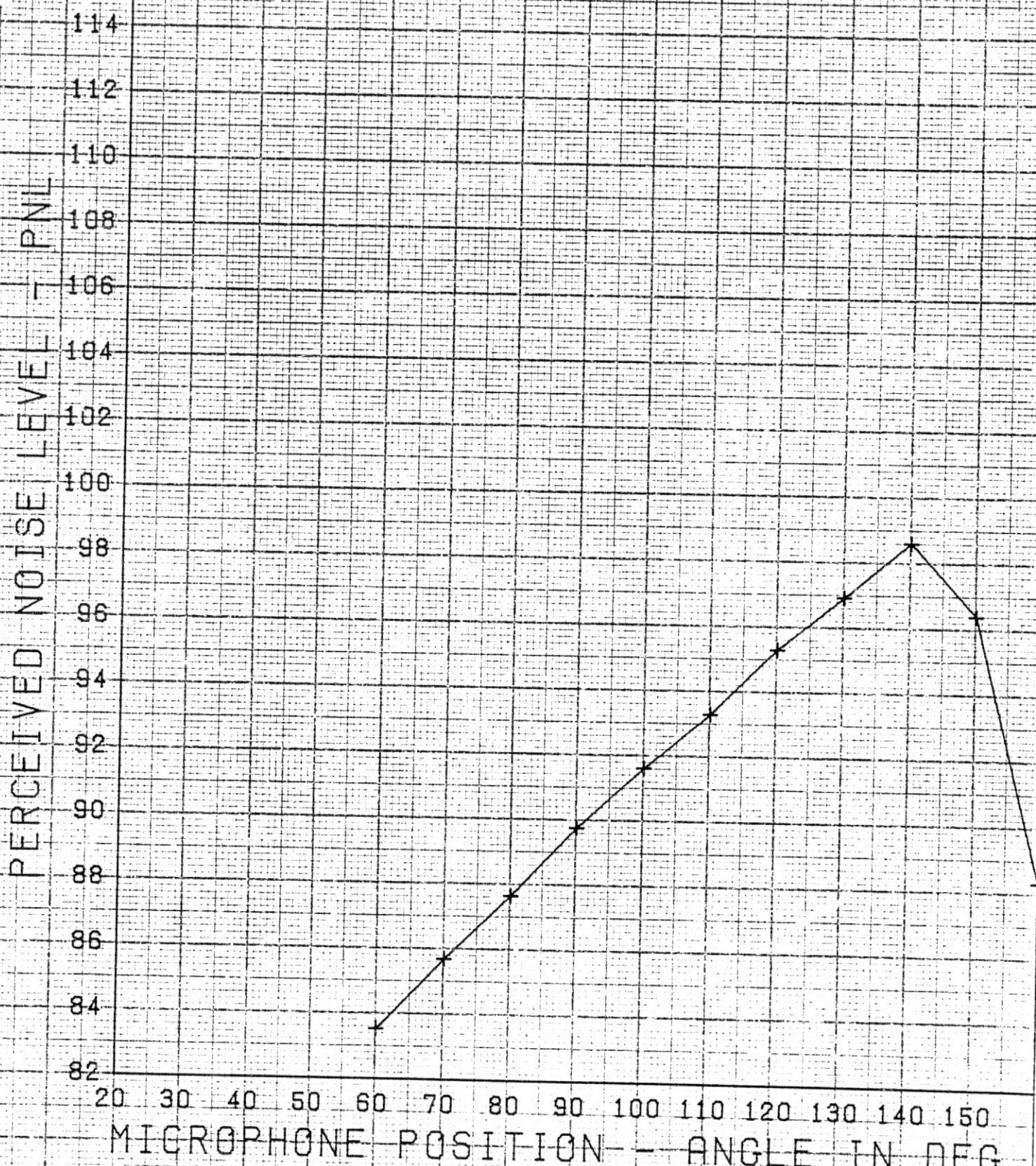
20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20084F TAPE P7339 VSCE CONF. C

15.2049

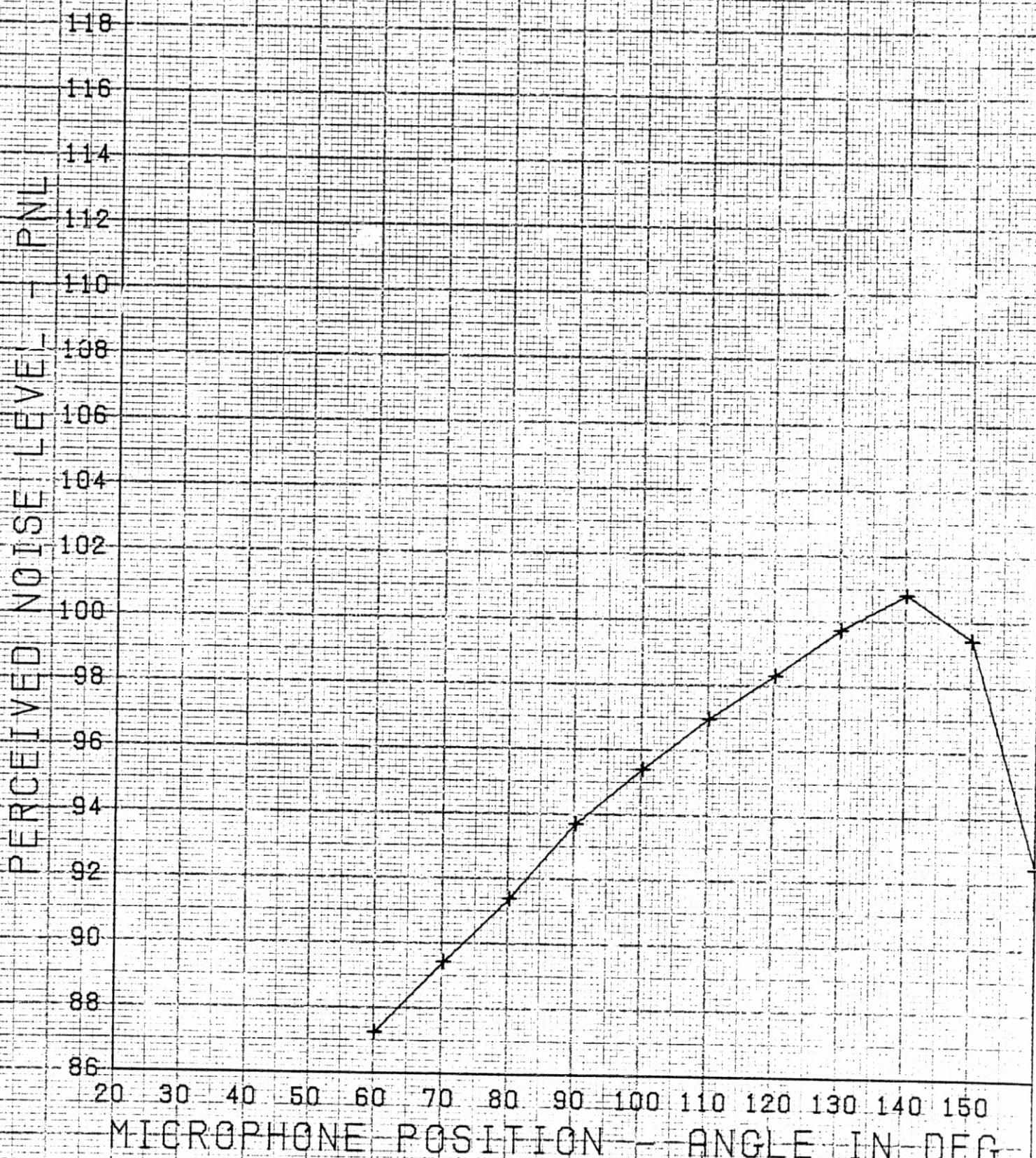
116 ALTITUDE = 0 , 2120 FT SIDELINE
ENGINE CONDITION = 8408



90084F TAPE P7333 VSCE CONF. C

15.2049

120 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8409



20084F TAPE P7333 VSCE CONF. C

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8410

PERCEIVED NOISE LEVEL - PNL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150
MICROPHONE POSITION - ANGLE IN DEG



20084F TAPE P7333 VSCE CONF. C

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8411

PERCEIVED NOISE LEVEL - PNL

124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20084F TAPE P7334 VSCE CONF. C

15.2049

122 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8412

PERCEIVED NOISE LEVEL - PNL

120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88

20 30 40 50 60 70 80 90 100 110 120 130 140 150

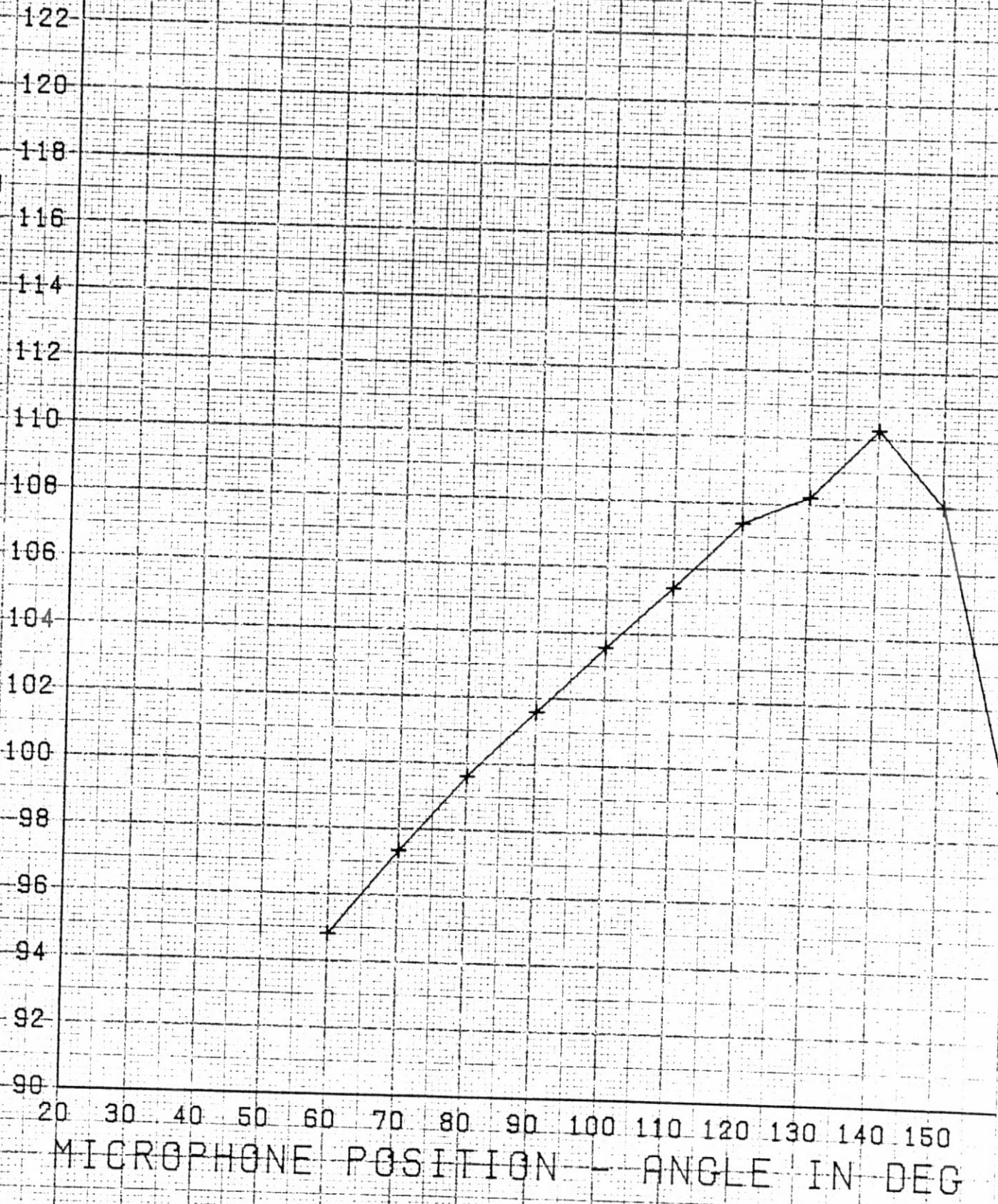
MICROPHONE POSITION - ANGLE IN DEG

20084F TAPE P7334 VSCE CONF. C

15.2049

124 ALTITUDE = 0 FT SIDELINE
ENGINE CONDITION = 8419

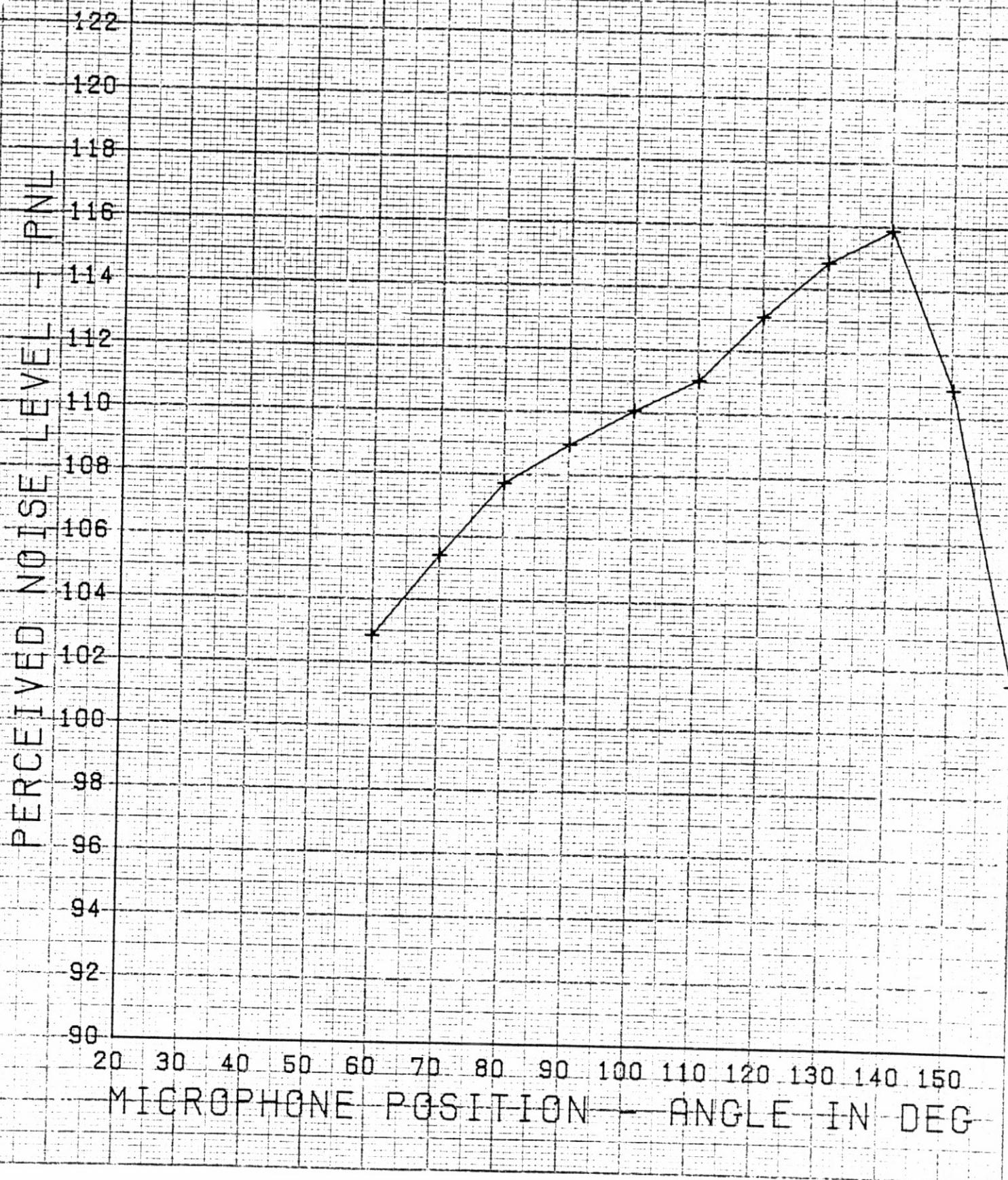
PERCEIVED NOISE LEVEL - PNLL



20084F TAPE P7334 VSCE CONF. C

15.2049

1-24 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8414



20085F TAPE P7338 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

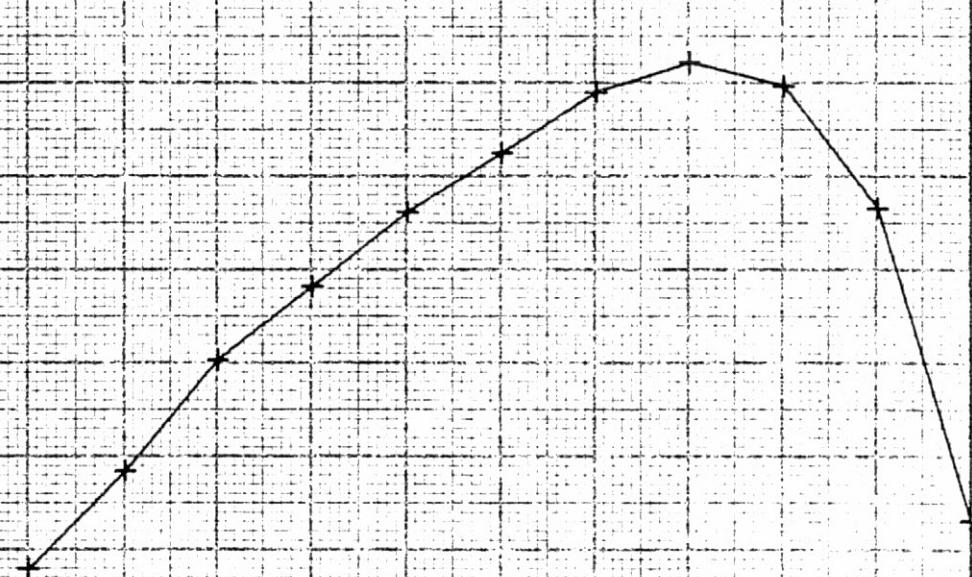
110 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8501

PERCEIVED NOISE LEVEL - PNL

110
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG



20085F TAPE P7338 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

118 ALTITUDE = 0 , 2120 FT SIDELINE
ENGINE CONDITION = 8502

PERCEIVED NOISE LEVEL - PNL

118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86
84

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20085F TAPE P7338 NASA VSCE (NAS3-20081) CONFIG. D

15.2049

ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8503

PERCEIVED NOISE LEVEL - PNL

124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

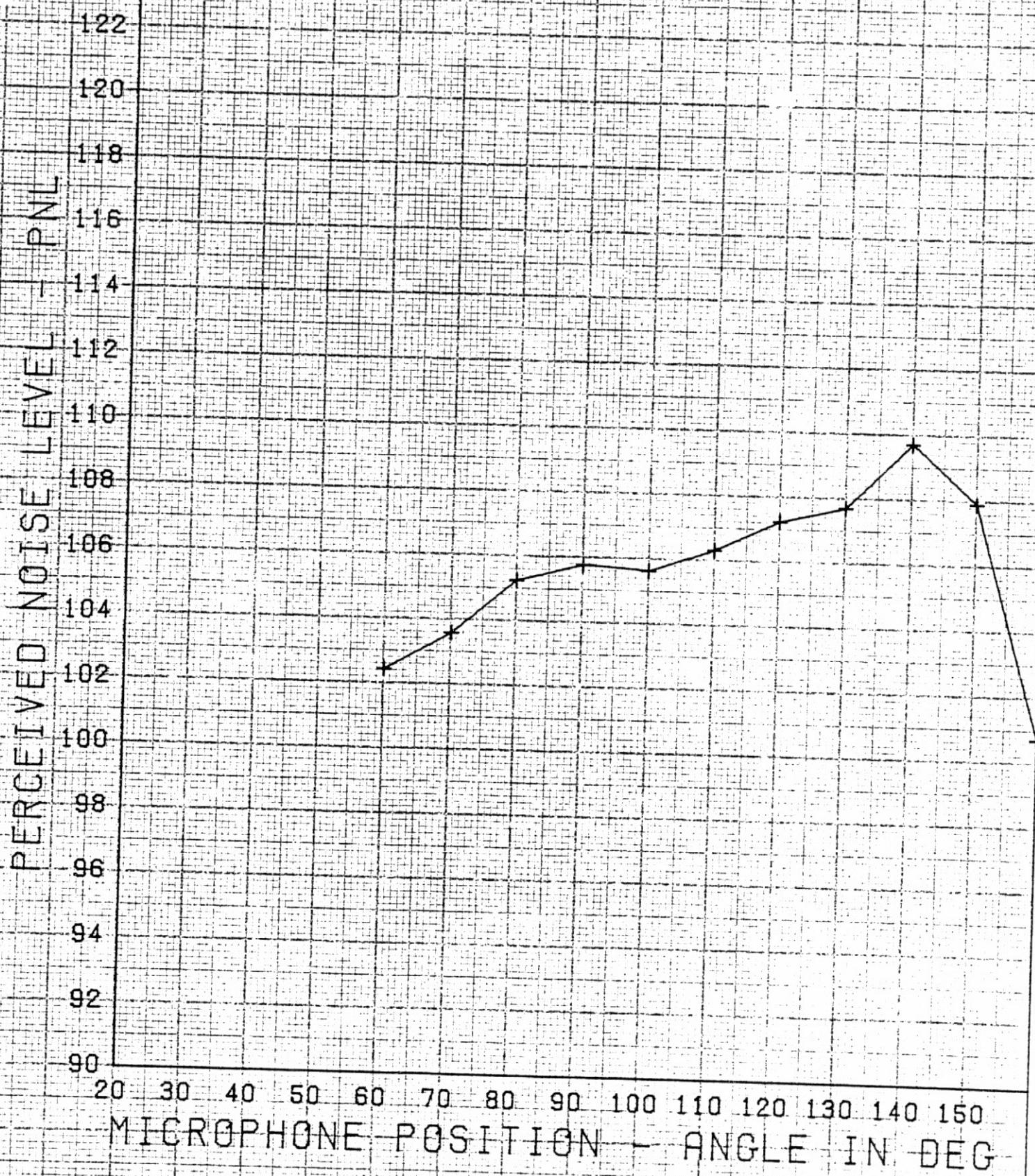
20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20085F TAPE P7338 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

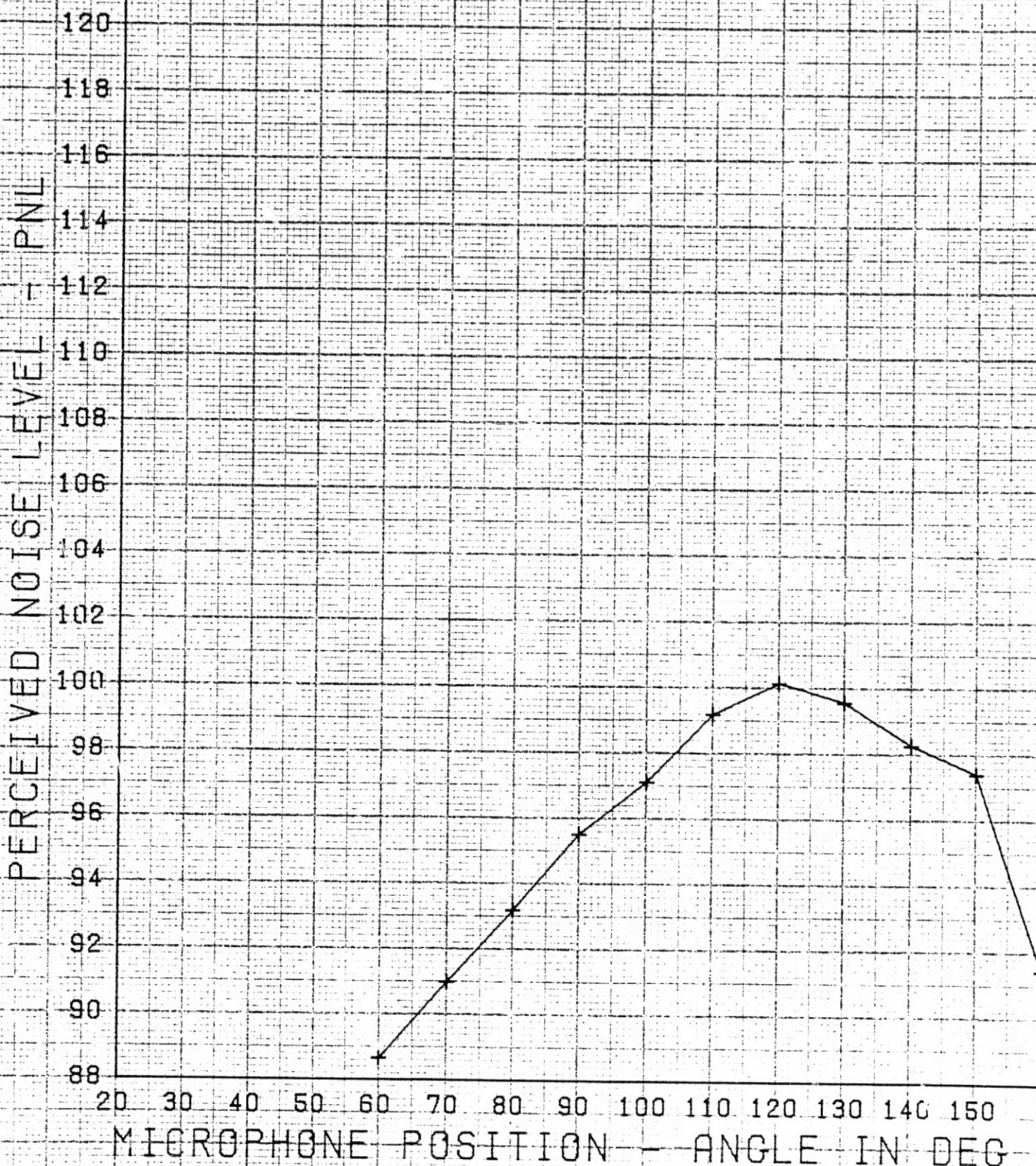
124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8504



20085F TAPE P7339 NASA VSCE (NAS3-20081) CONFIG. D

15.2049

122 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8505



20085F TAPE P7339 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
122 ENGINE CONDITION = 8506

PERCEIVED NOISE LEVEL - PN

124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20085F TAPE P7339 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8507

PERCEIVED NOISE LEVEL - PNL

124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

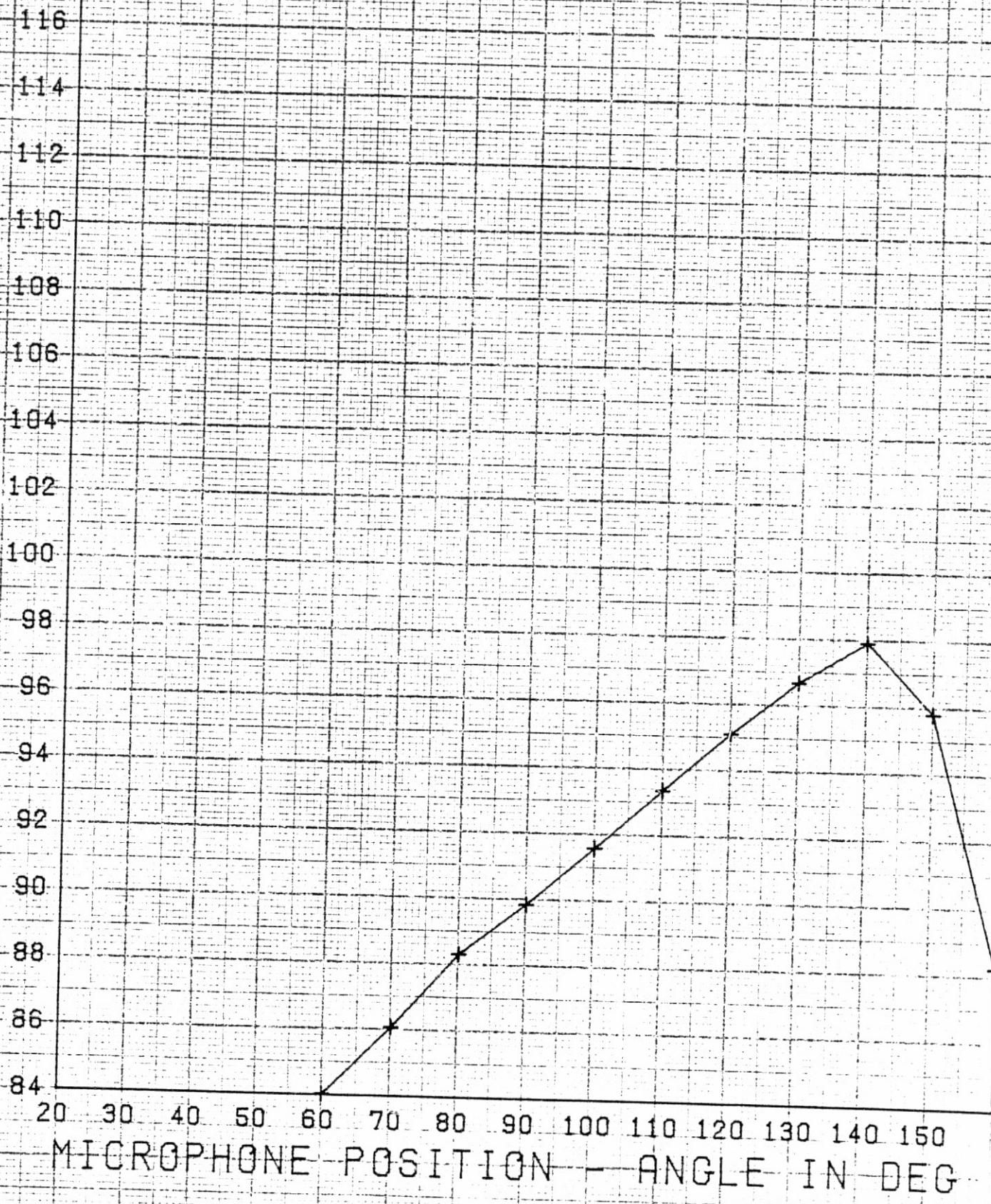
MICROPHONE POSITION - ANGLE IN DEG

20085F TAPE P7338 NASA VSCE (NAS3-20081) CONFIG. D

15.2049

118 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8508

PERCEIVED NOISE LEVEL - PNL



20085F TAPE P7338 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

120 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8509

PERCEIVED NOISE LEVEL - PNL

120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86

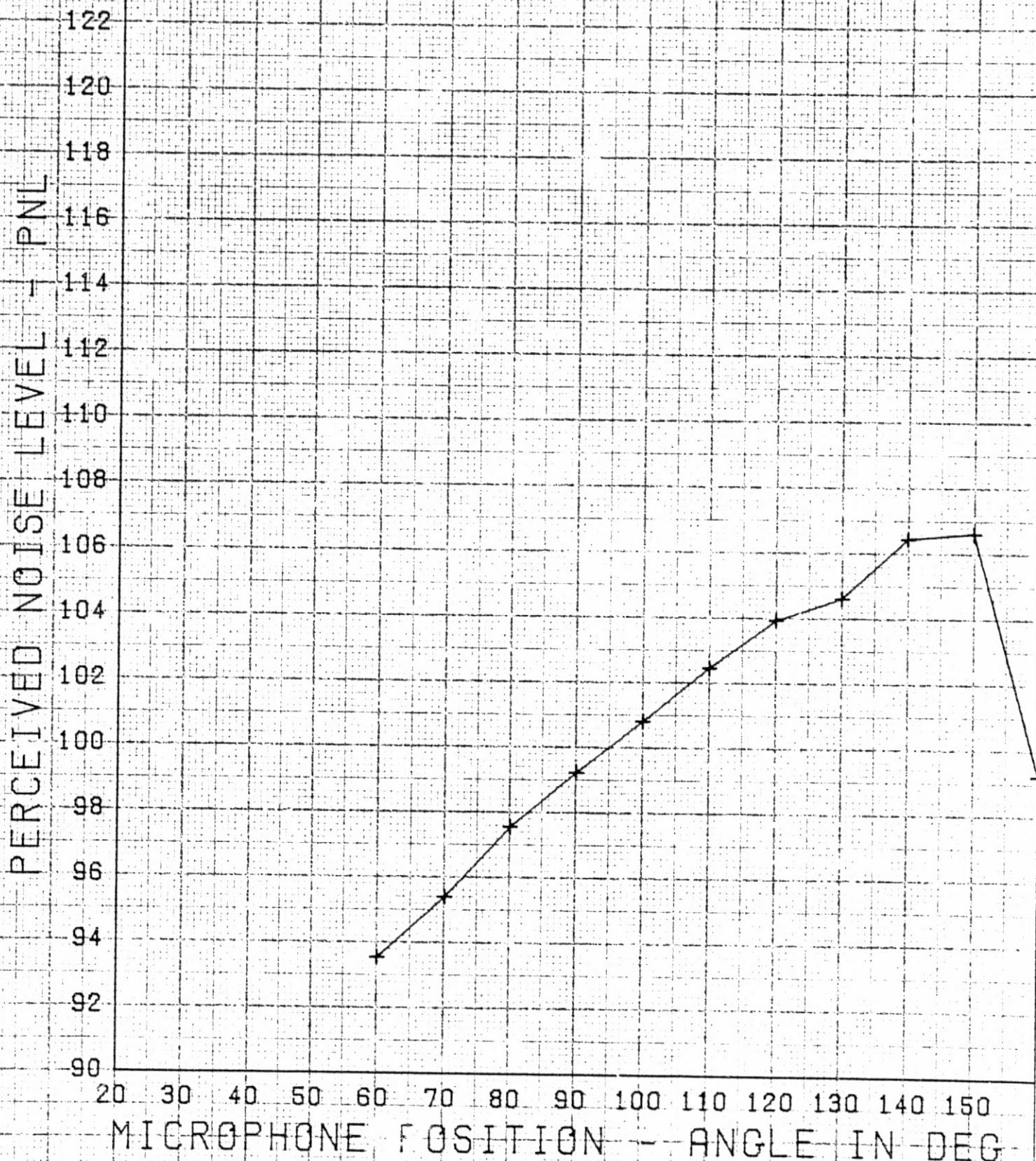
20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20085F TAPE P7338 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8510



20085F TAPE P7338 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8511

PERCEIVED NOISE LEVEL - PNL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

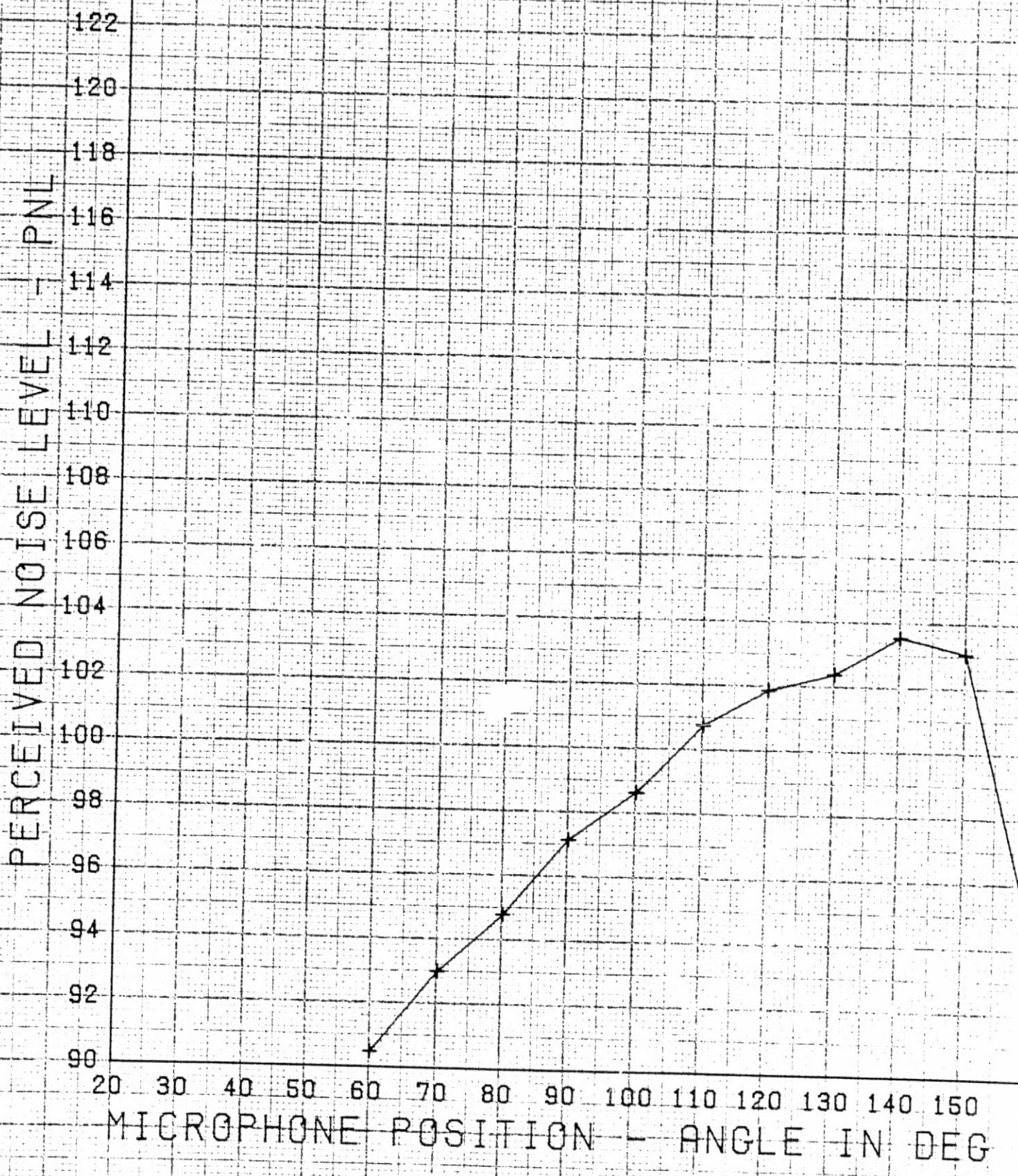
20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20085F TAPE P7339 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

124 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8512



20085F TAPE P7339 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

124 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8513

PERCEIVED NOISE LEVEL - PNLL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION ANGLE IN DEG

20085F TAPE P7339 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8514

PERCEIVED NOISE LEVEL PNL

124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

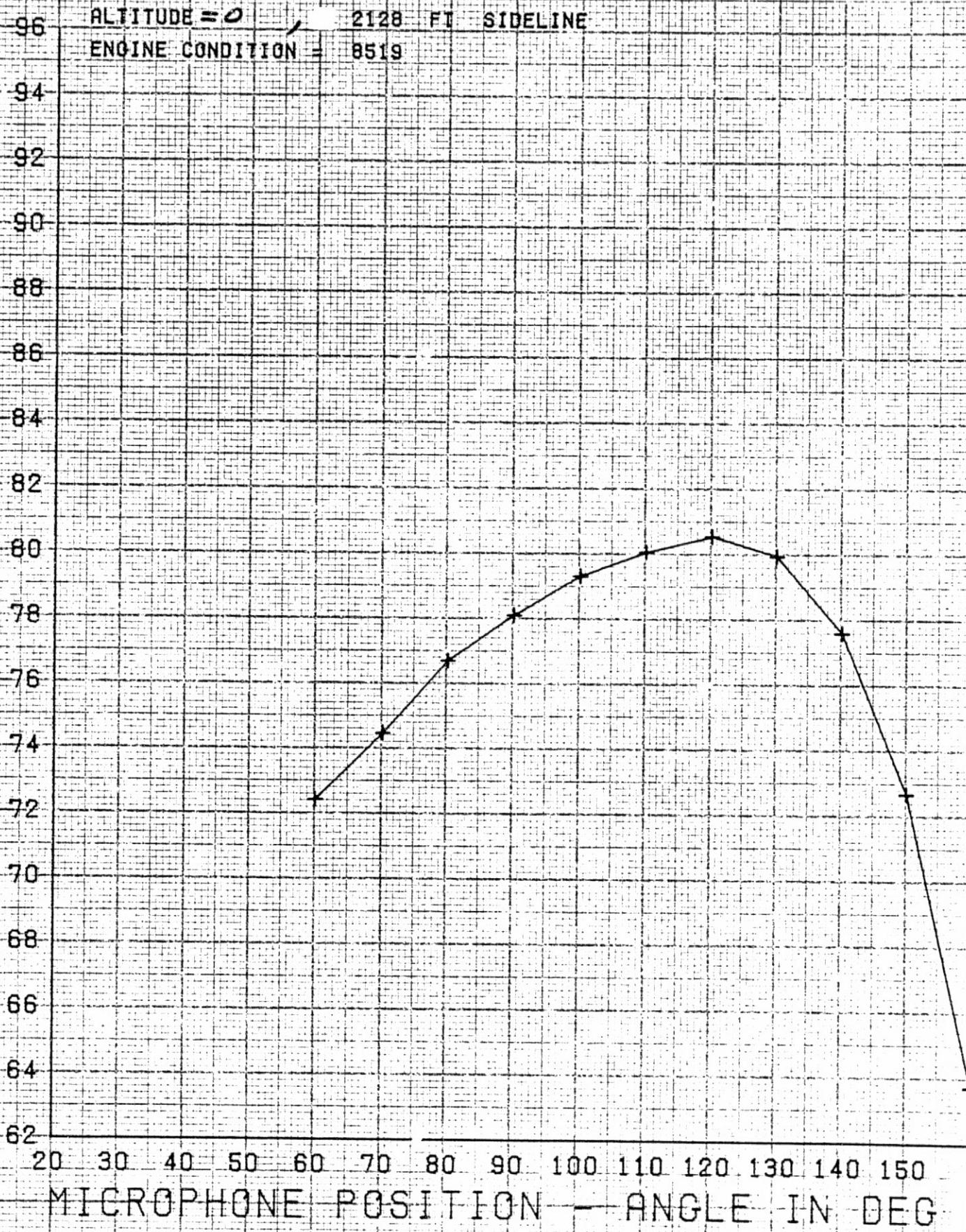
MICROPHONE POSITION — ANGLE IN DEG

20085F TAPE P7338 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8519

PERCEIVED NOISE LEVEL - PNL

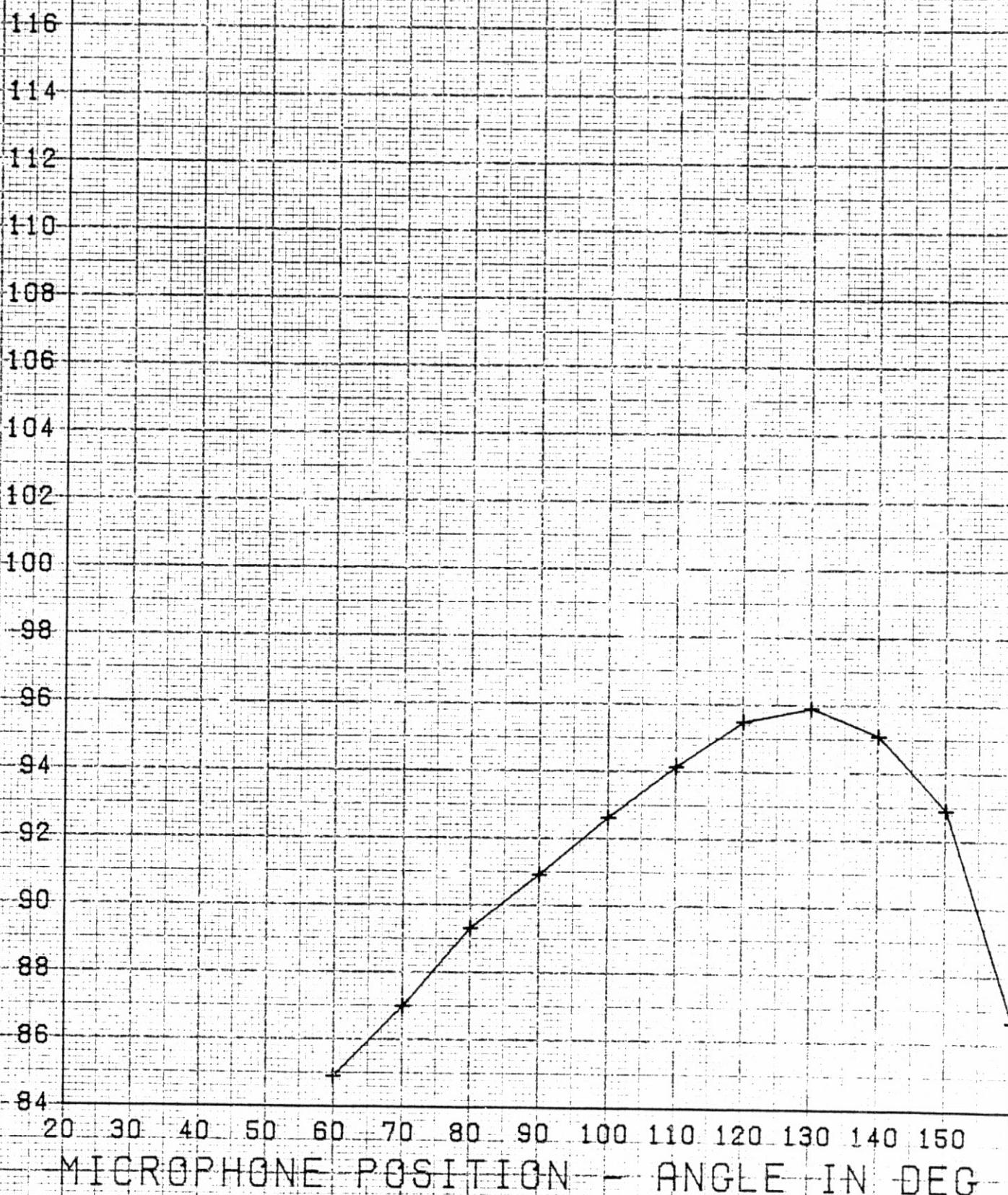


20085F TAPE P7338 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

118 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8520

PERCEIVED NOISE LEVEL - PNLL



20085F TRPE P7339 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8521

PERCEIVED NOISE LEVEL PNL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20085F TAPE P7339 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8522

PERCEIVED NOISE LEVEL PNL

124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

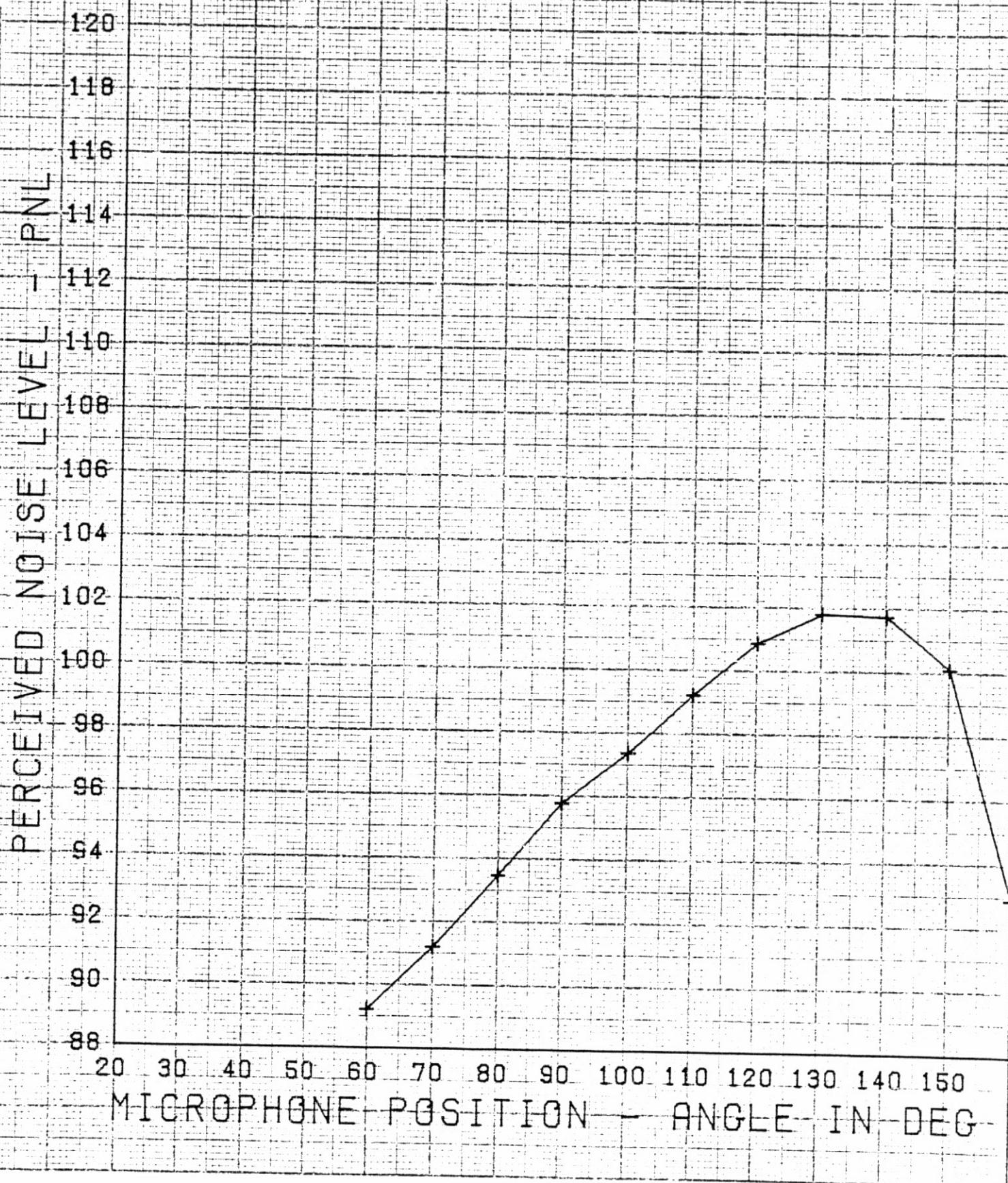
20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20085F TAPE P7339 NASA VSCE (NAS3-2006) CONFIG. D

15.2049

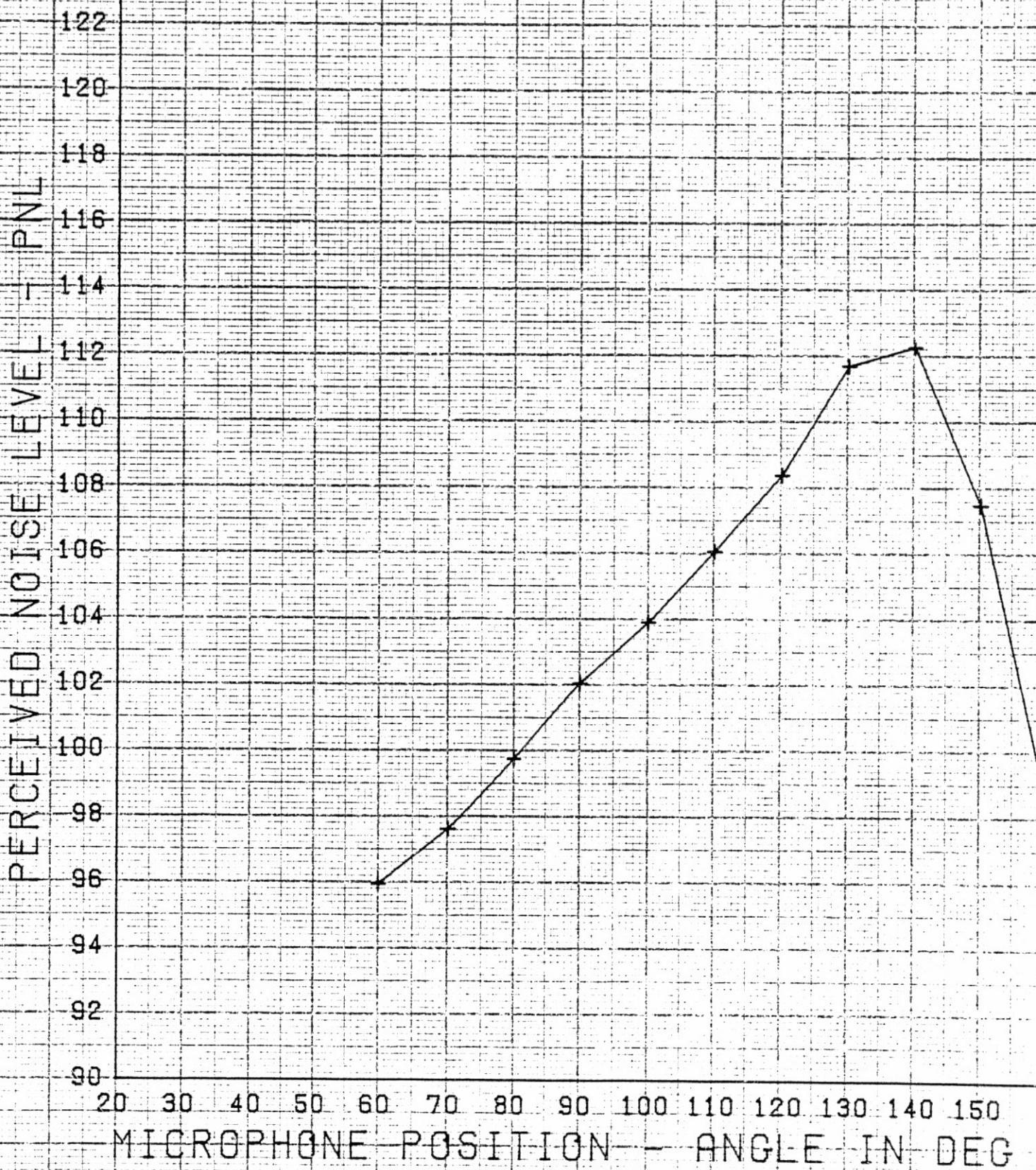
122 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8523



20085F TAPE P7339 NASA VSCE (NAS3-20061) CONFIG. D

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8524



20085F TAPE P7339 NASA VSCE (NAS3-20081) CONFIG. D

15.2049

124 ALTITUDE = 0 , 2120 FT SIDELINE
ENGINE CONDITION = 8525

PERCEIVED NOISE LEVEL PNL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20086F TAPE P7493 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

110 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8601

PERCEIVED NOISE LEVEL - PNL

108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76

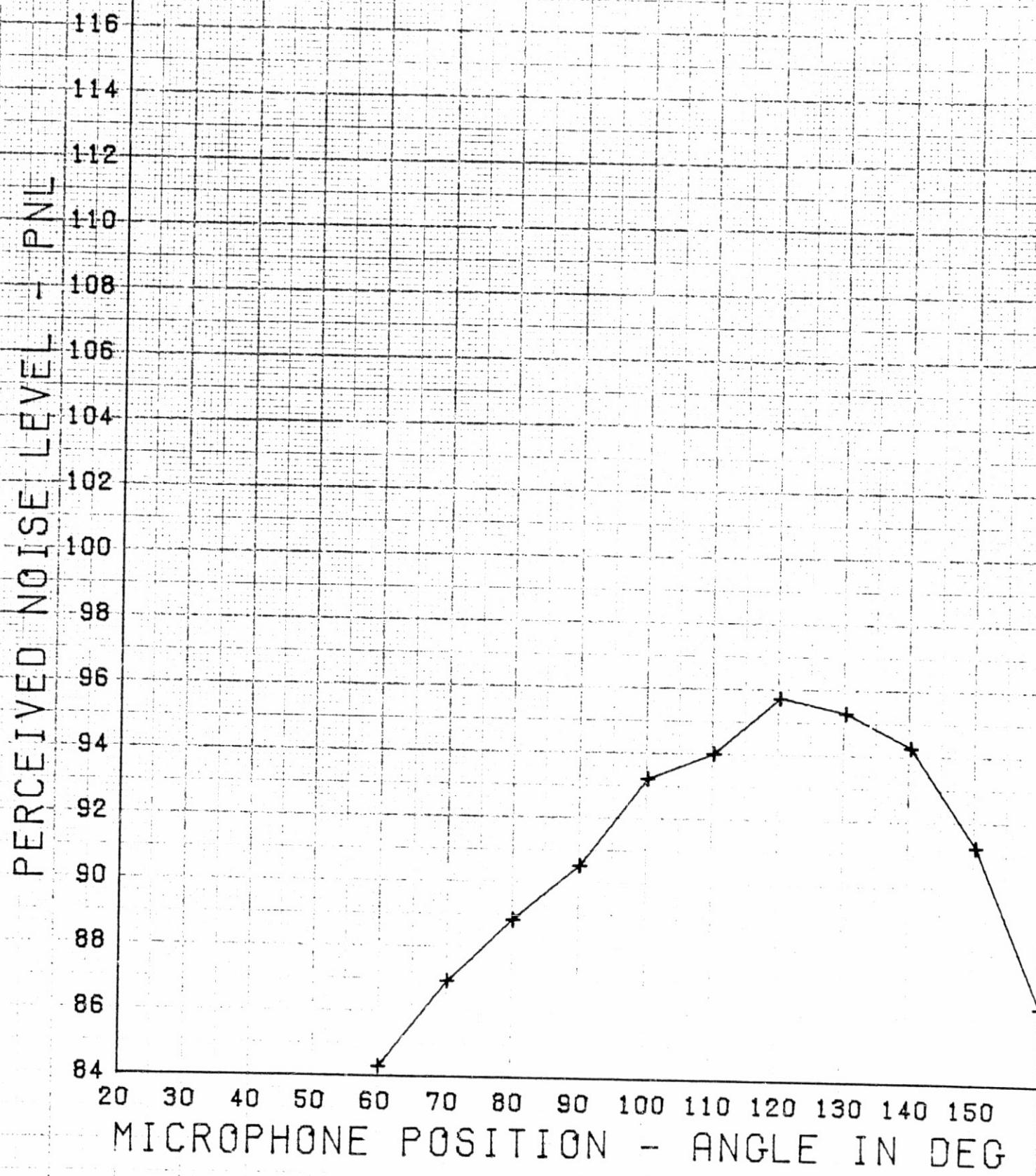
20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20086F TAPE P7493 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

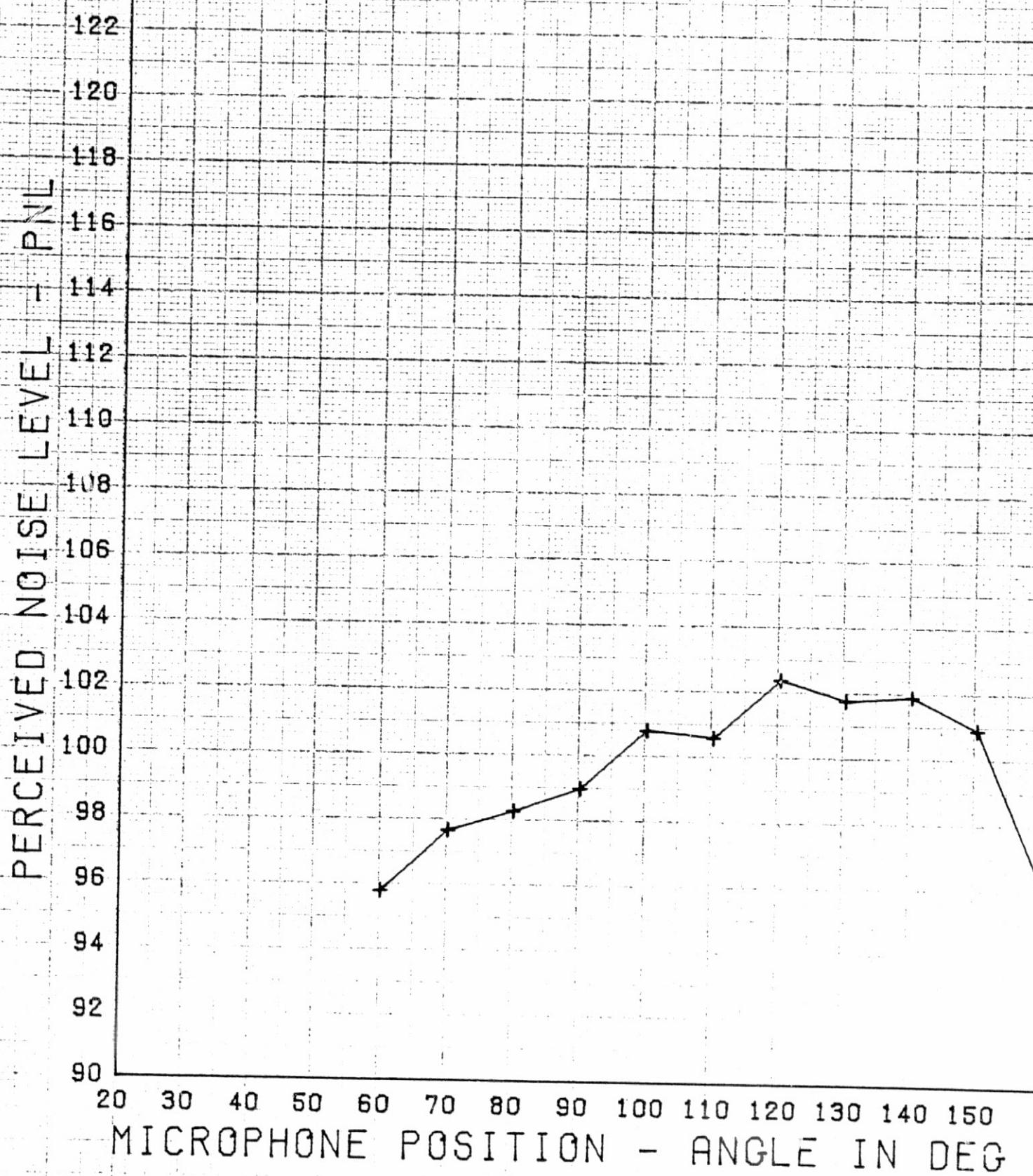
118 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8602



20086F TAPE P7493 NASA VSCE (NAS3-20061) CONFIG. E

15-2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8603



20086F TAPE P7493 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

124 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8604

PERCEIVED NOISE LEVEL - PNLL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20086F TAPE P7493 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8605

PERCEIVED NOISE LEVEL - PNL

120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20086F TAPE P7493 NASA VSCE (NAS3-20061) CONFIG. E

15-2049

124 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8606

PERCEIVED NOISE LEVEL - PNL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20086F TAPE P7494 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8607

PERCEIVED NOISE LEVEL - PNL

124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

29086F TAPE P7493 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

116 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8608

PERCEIVED NOISE LEVEL - PNL

114
112
110
108
106
104
102
100
98
96
94
92
90
88
86
84
82

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20086F TAPE P7493 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8609

PERCEIVED NOISE LEVEL - PNL

120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20086F TRPE P7493 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

124 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = B610

PERCEIVED NOISE LEVEL - PNL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

086F TAPE P7493 NASA VSCE (NAS3-20061) CONFIG. E

15-2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8611

PERCEIVED NOISE LEVEL - PNLL

122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20086F TAPE P7494 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

122 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8612

PERCEIVED NOISE LEVEL - PNL

120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88

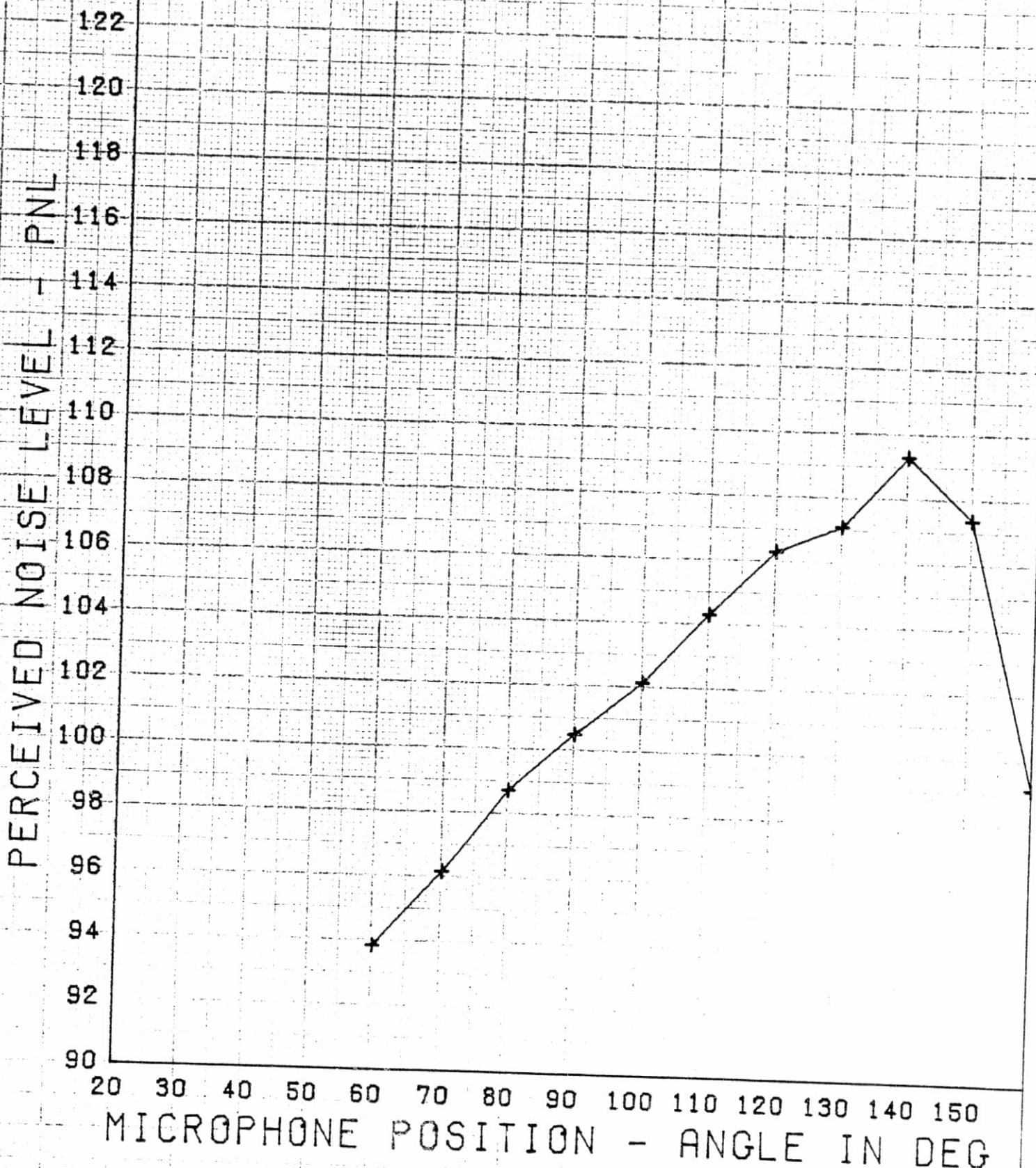
20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20086F TAPE P7494 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

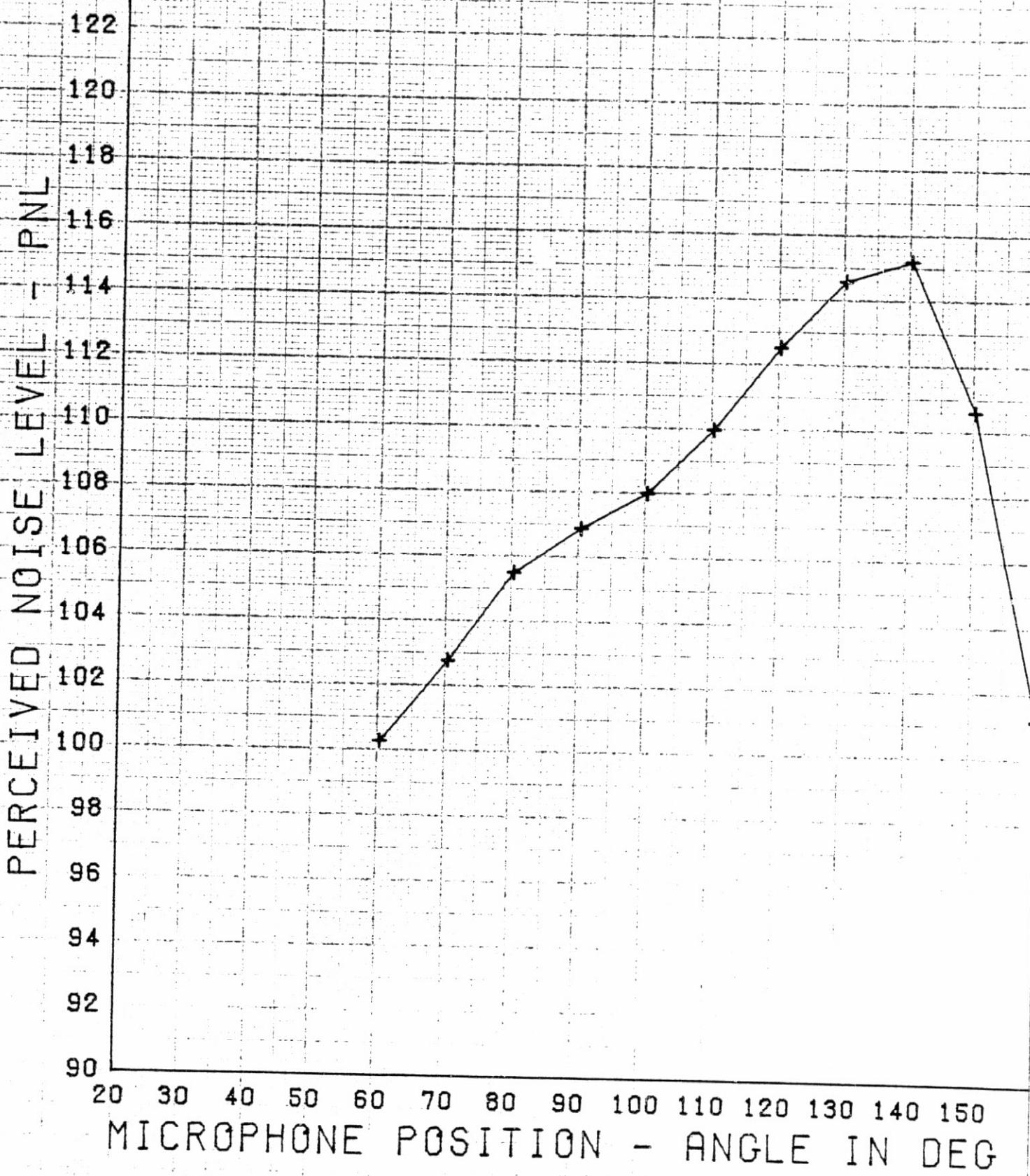
124 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8613



20086F TAPE P7494 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8614



20086F TAPE P7-94 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8626

PERCEIVED NOISE LEVEL - PNL

96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62

20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

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OF POOR QUALITY

C - 2

A-89

0086F TRPE P7494 NASA VSCE (NAS3-20081) CONFIG. E

15.2049

114 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8627

PERCEIVED NOISE LEVEL - PNL

112
110
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80

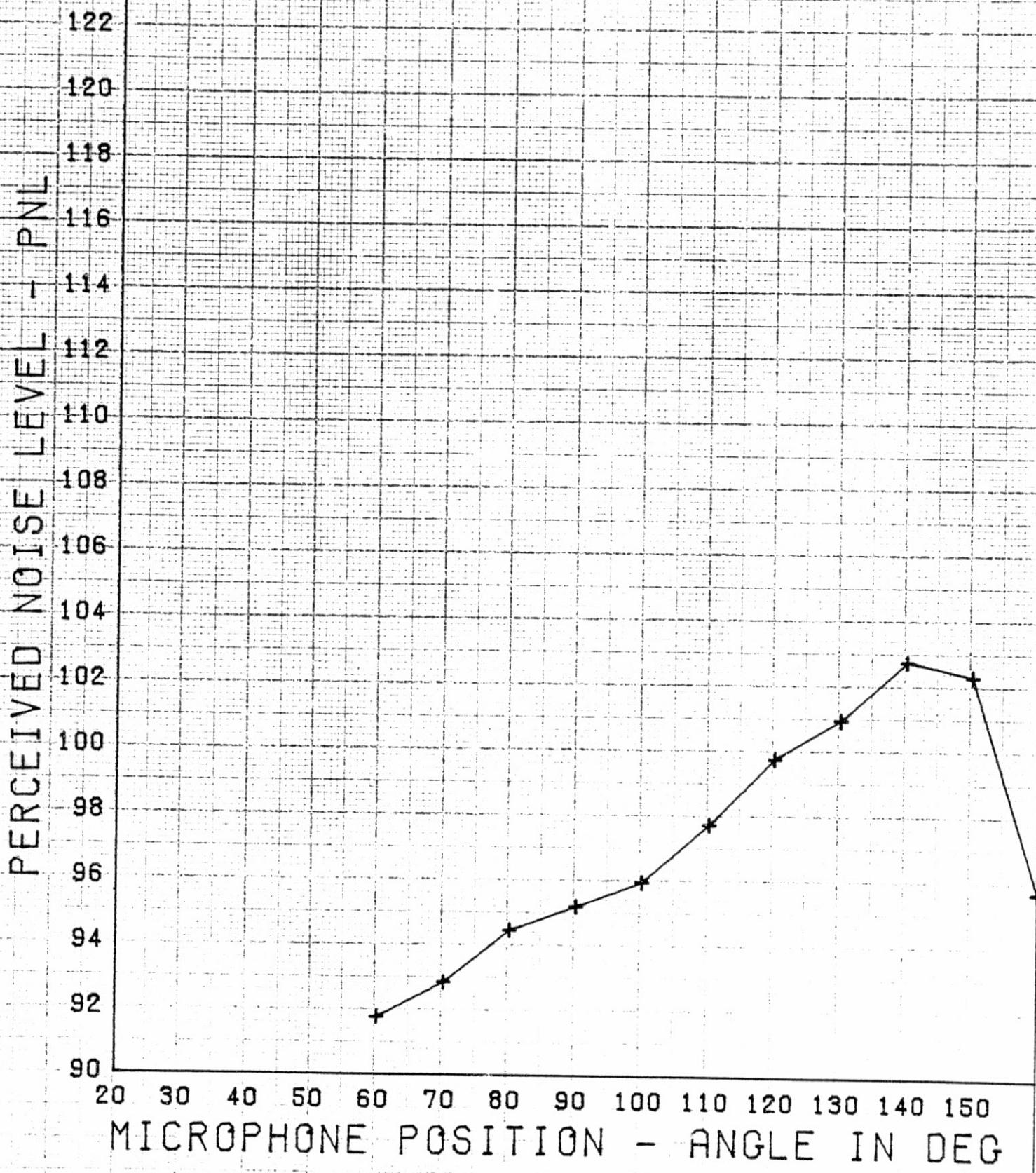
20 30 40 50 60 70 80 90 100 110 120 130 140 150

MICROPHONE POSITION - ANGLE IN DEG

20086F TAPE P7494 NASA VSCE (NAS3-20061) CONFIG. E

15-2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8628

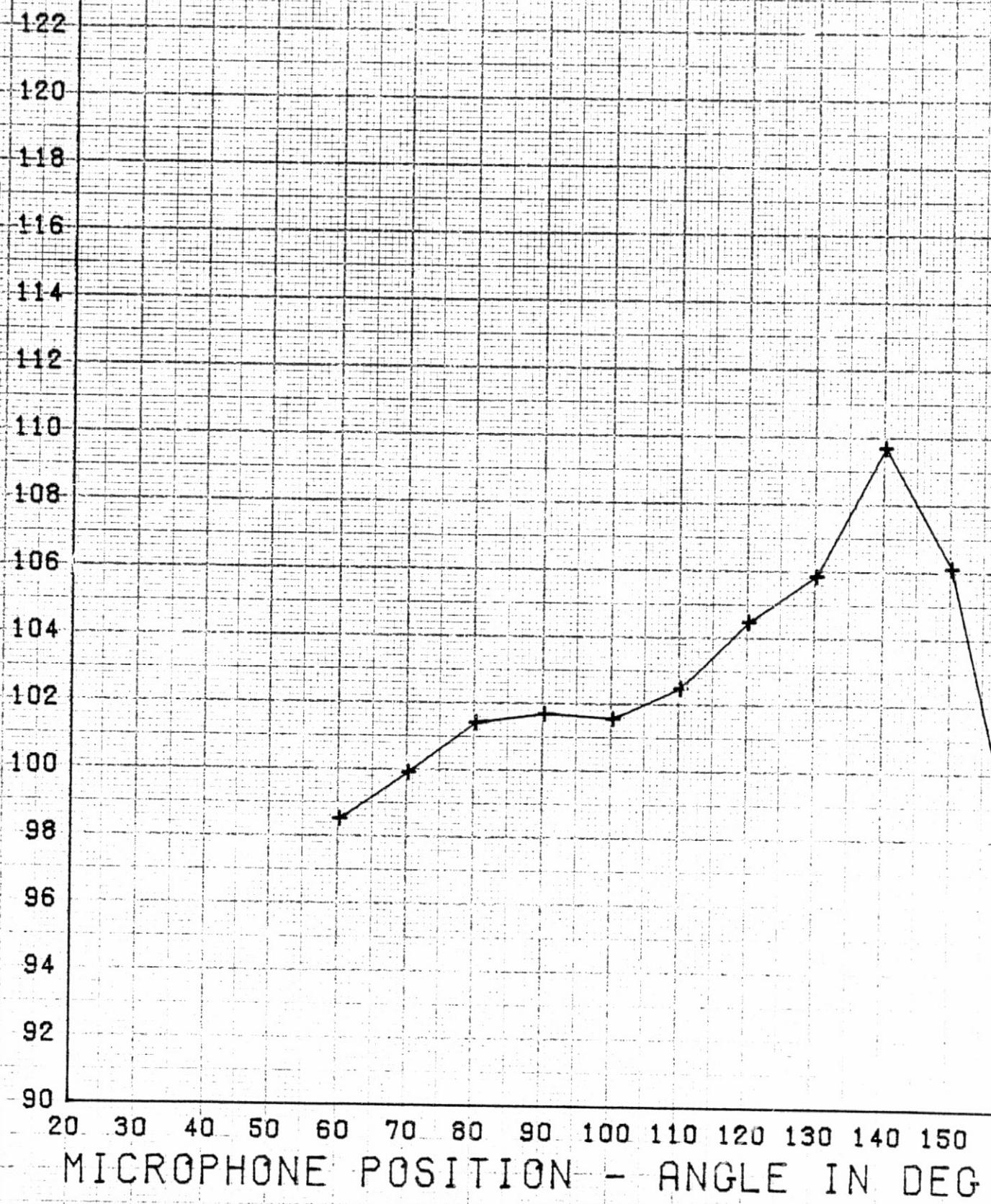


20086F TAPE P7494 NASA VSCE (NAS3-20081) CONFIG. E

15.2049

124 ALTITUDE = 0 / 2128 FT SIDELINE
ENGINE CONDITION = 8629

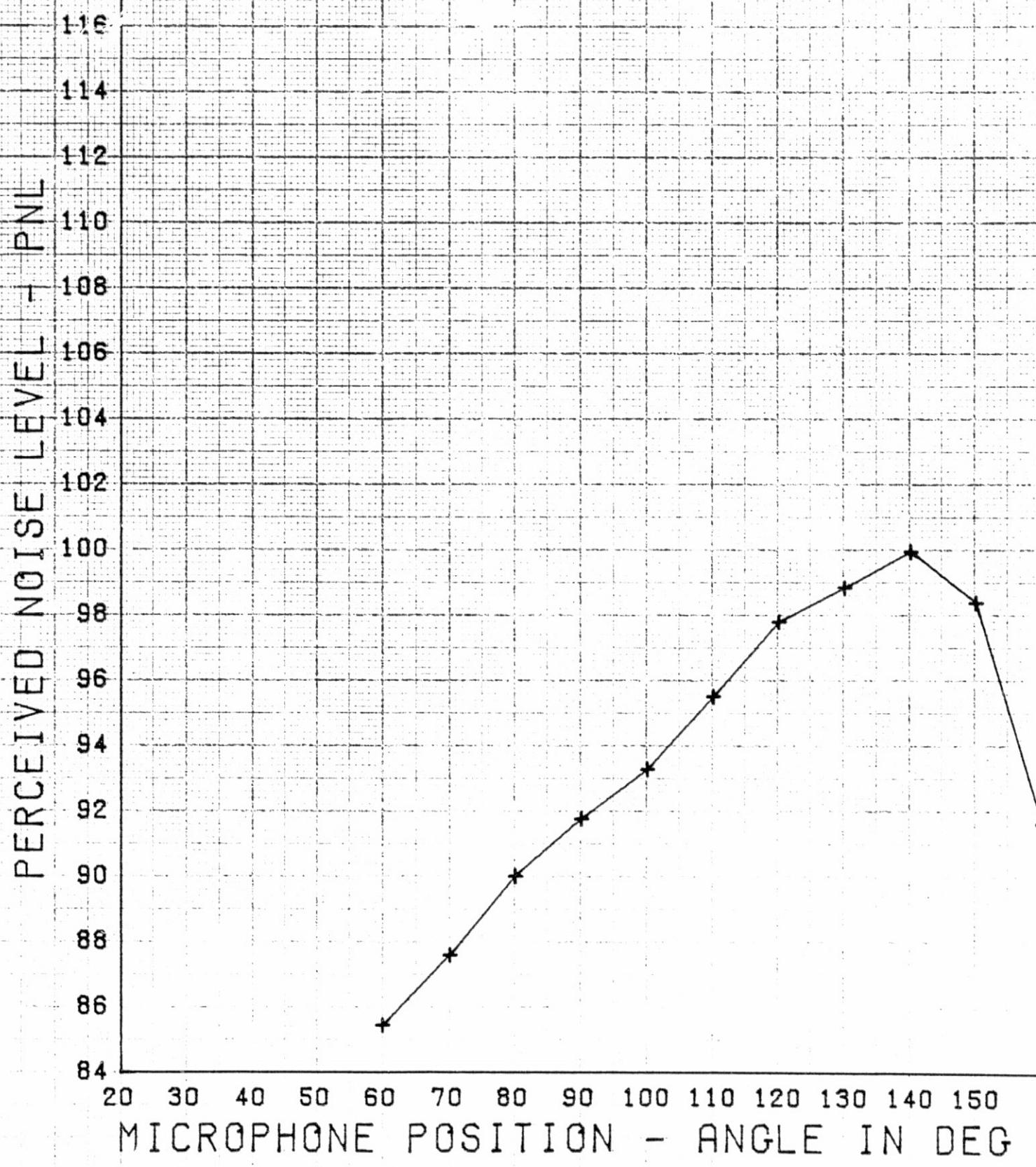
PERCEIVED NOISE LEVEL - PNL



20086F TAPE P7494 NASA VSCE (NP53-20061) CONFIG. E

15.2048

118 ALTITUDE = 0 2128 FT SIDELINE
ENGINE CONDITION = 8630



0086F TAPE P7494 NASA VSCE (NAS3-20061) CONFIG. E

15.2049

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8631

PERCEIVED NOISE LEVEL - PNL

124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90

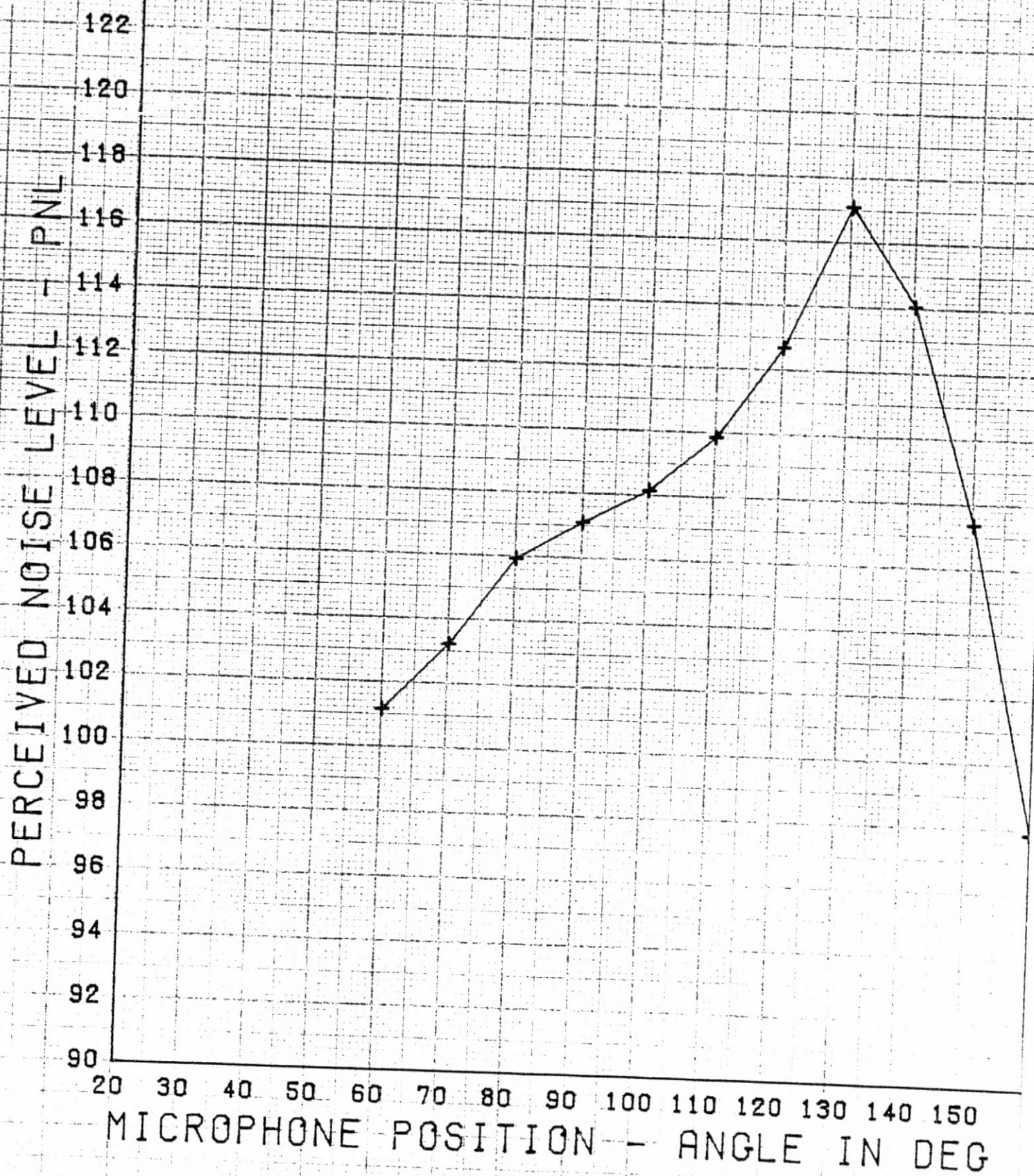
20 30 40 50 60 70 80 90 100 110 120 130 140 150

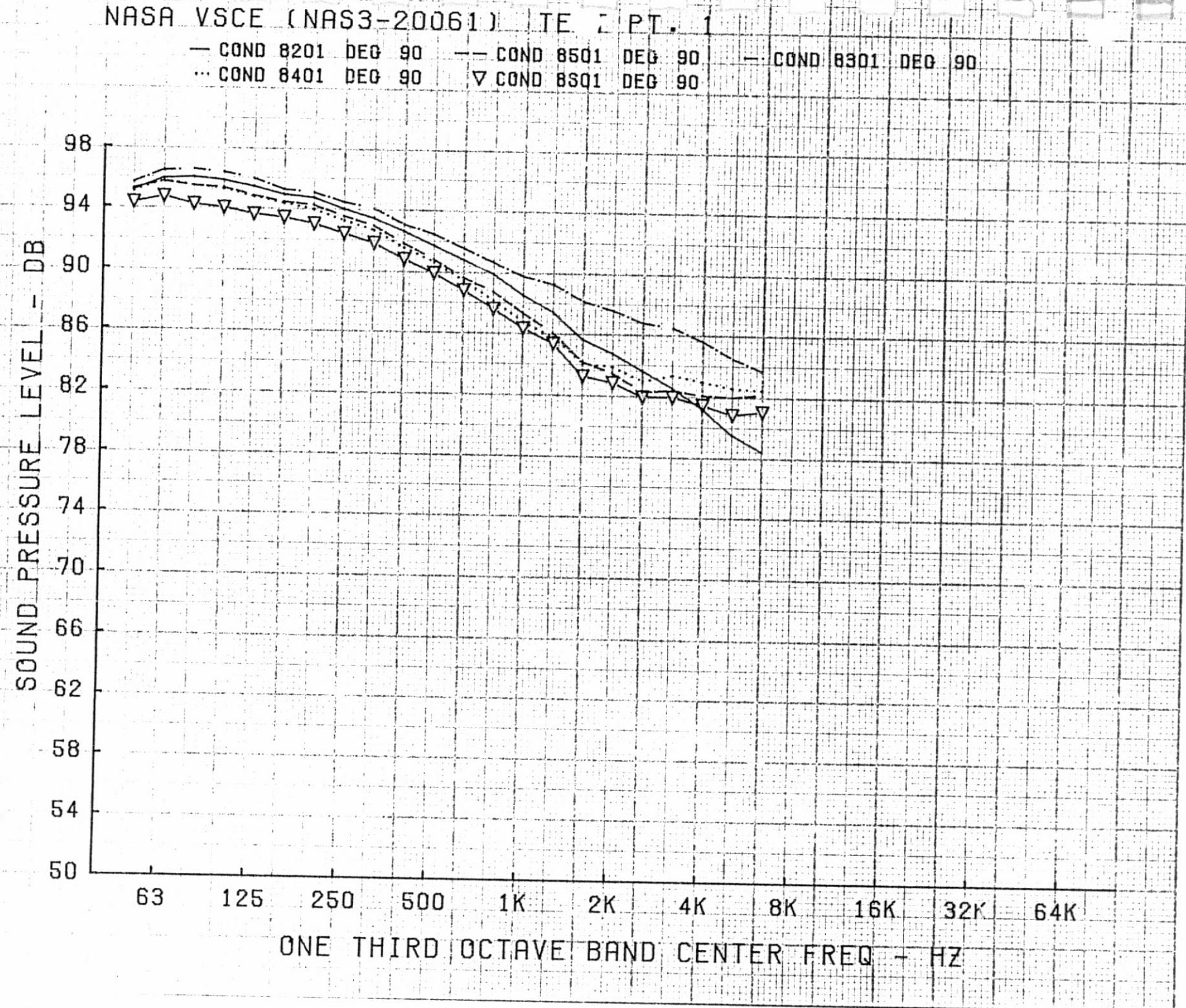
MICROPHONE POSITION - ANGLE IN DEG

20086F TAPE P7494 NASA VSCE [NAS3-20061] CONFIG. E

124 ALTITUDE = 0 , 2128 FT SIDELINE
ENGINE CONDITION = 8632

15.2049





NASA VSCE (NAS3-20061)ITE PT. 1

— COND 8201 DEG 120
... COND 8401 DEG 120

— COND 8501 DEG 120
▽ COND 8601 DEG 120

COND 8301 DEG 120

104

SOUND PRESSURE LEVEL - DB

100

96

92

88

84

80

76

72

68

64

60

56

63

125

250

500

1K

2K

4K

8K

16K

32K

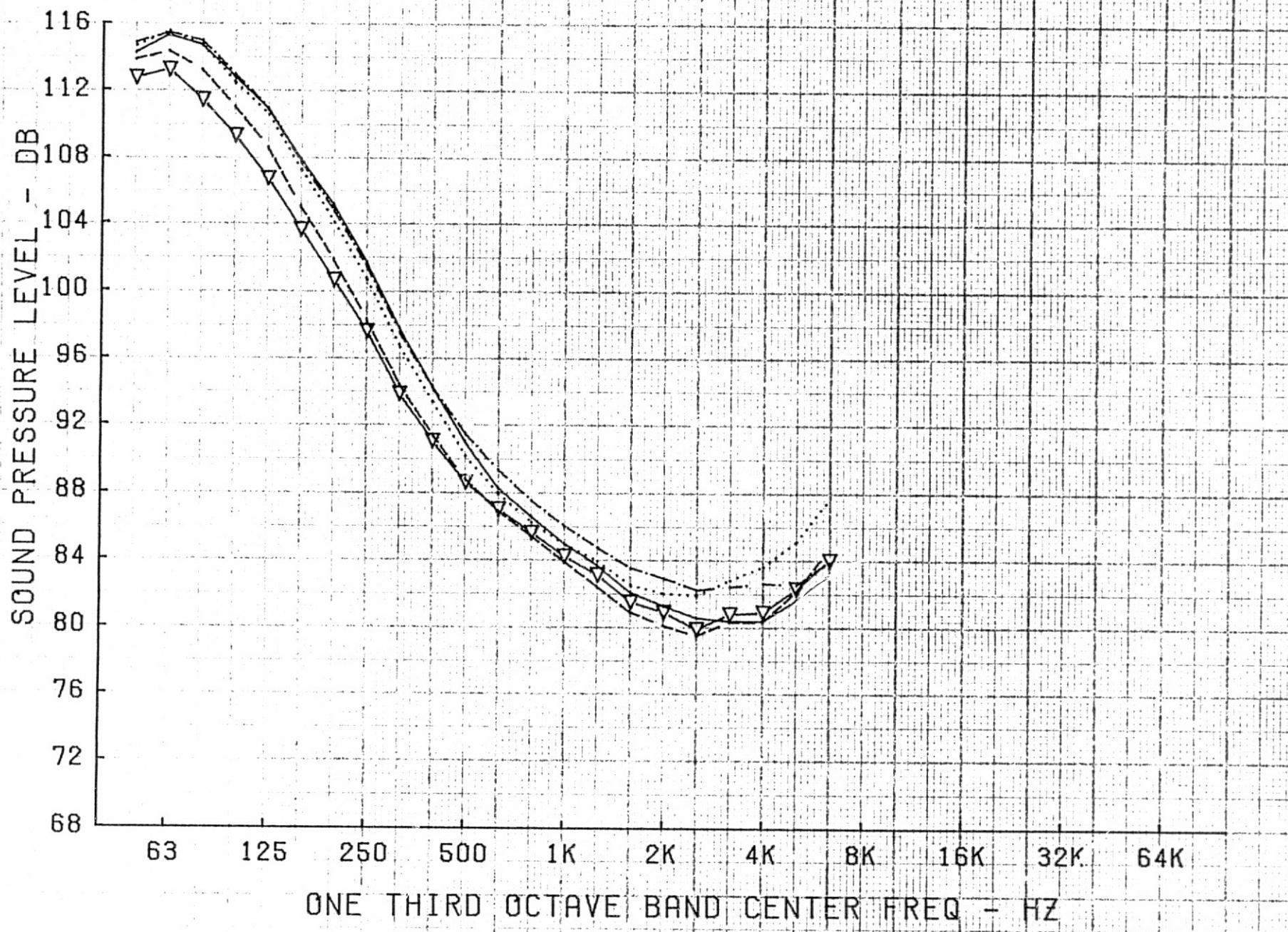
64K

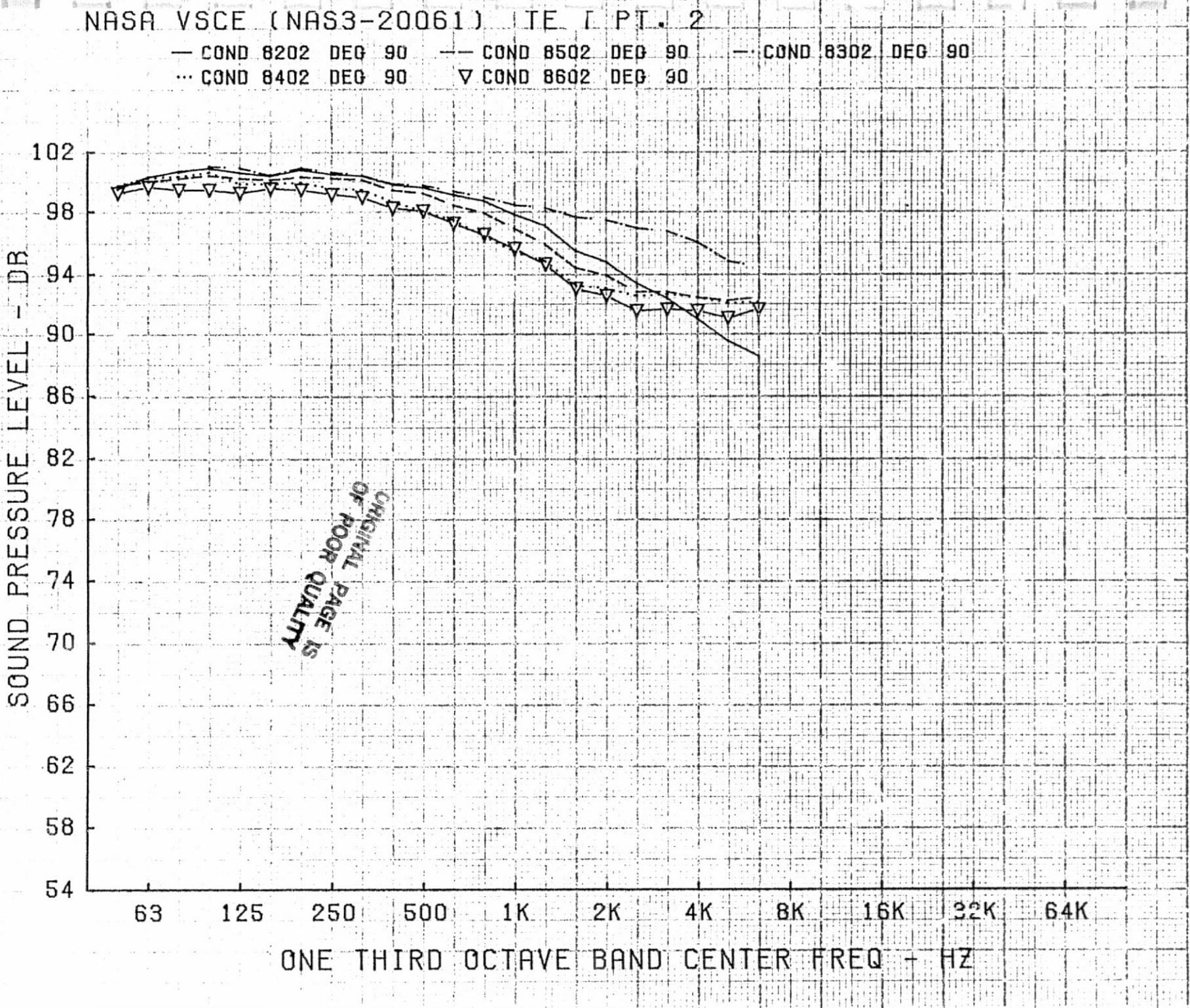
ONE THIRD OCTAVE BAND CENTER FREQ - Hz

NASA VSCE (NAS3-20061) TE. T PT. 1

— COND 8201 DEG 150
... COND 8401 DEG 150— COND 8501 DEG 150
▽ COND 8601 DEG 150

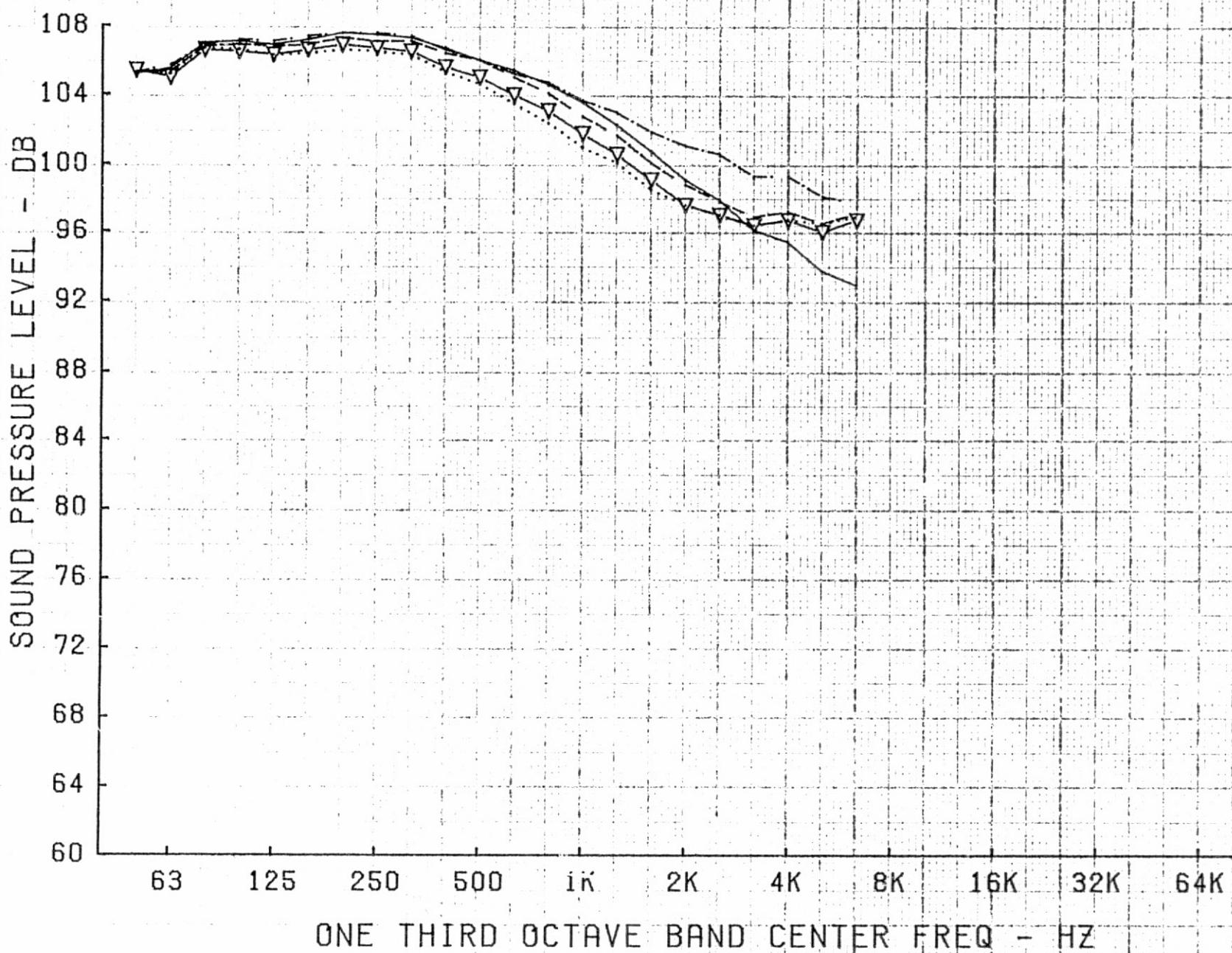
— COND 8301 DEG 150





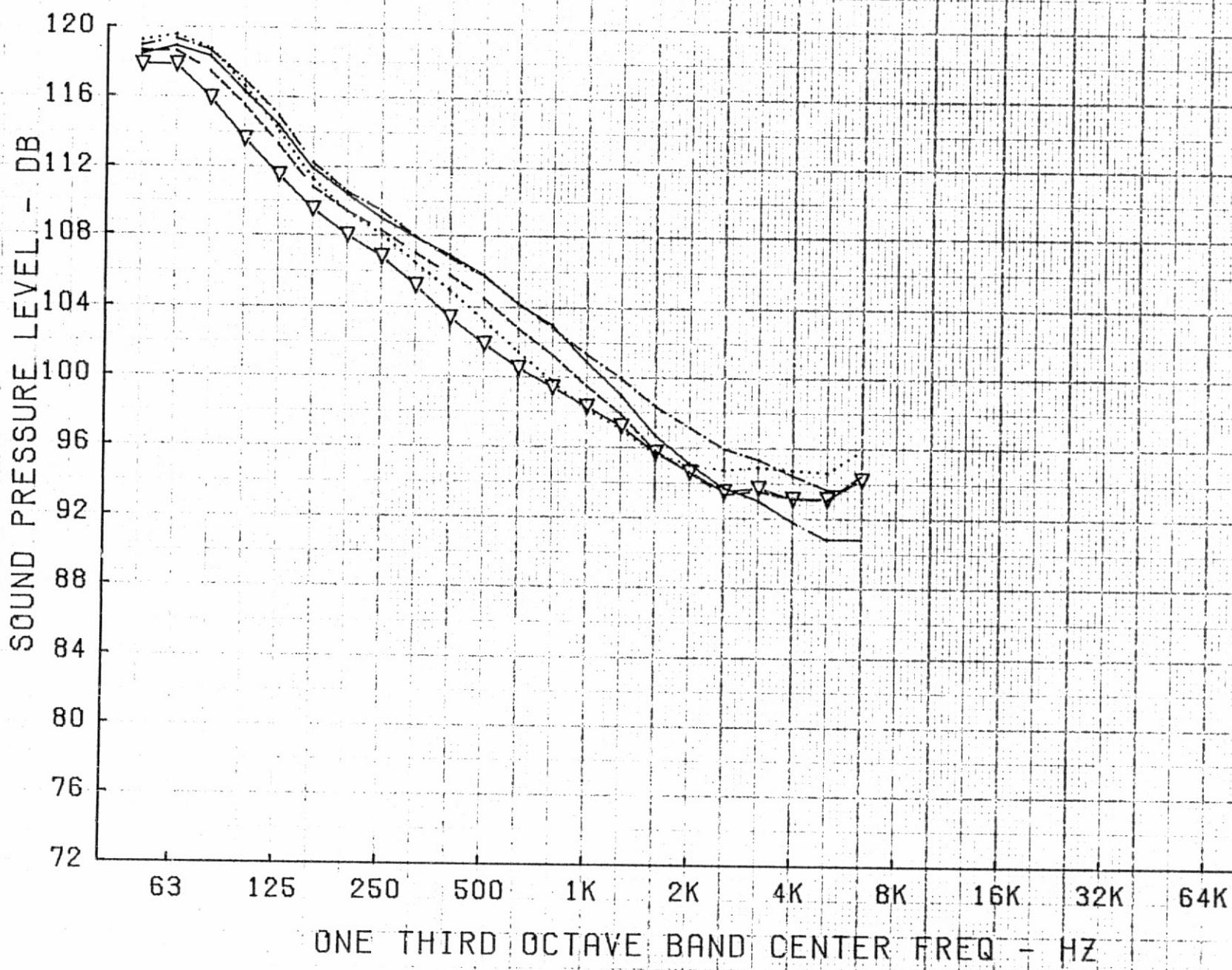
NASA VSCE (NAS3-20061) TE [PT. 2

— COND 8202 DEG 120 — COND 8502 DEG 120 — COND 8302 DEG 120
… COND 8402 DEG 120 ▽ COND 8602 DEG 120



NASA VSCE (NAS3-20061) LTE 7 PT. 2

— COND 8202 DEG 150 - - COND 8502 DEG 150 - COND 8302 DEG 150
... COND 8402 DEG 150 ▽ COND 8602 DEG 150



NASA VSCE (NAS3-20061) TE PPT. 3

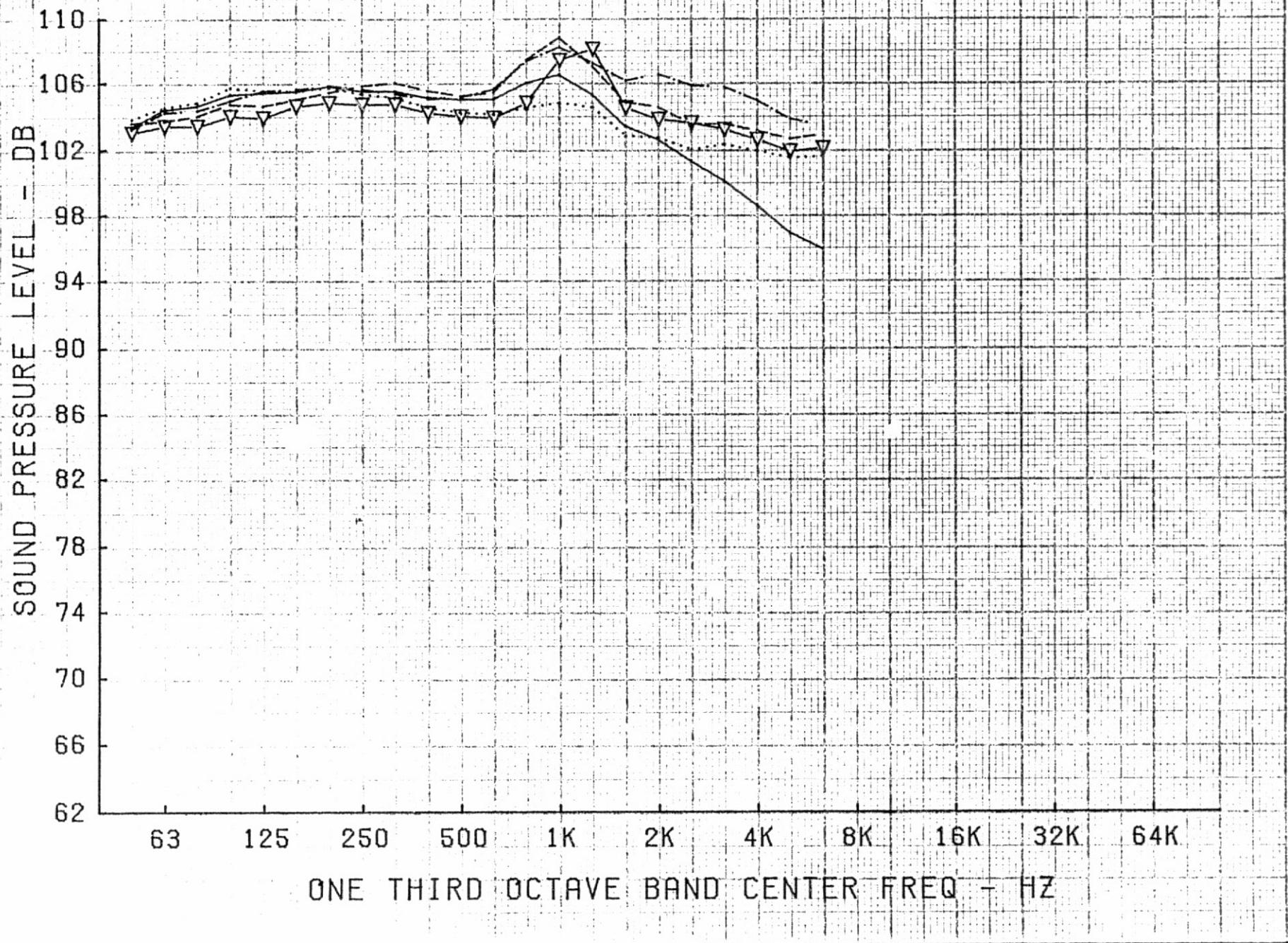
— COND 8203 DEG 90

... COND 8403 DEG 90

-- COND 8503 DEG 90

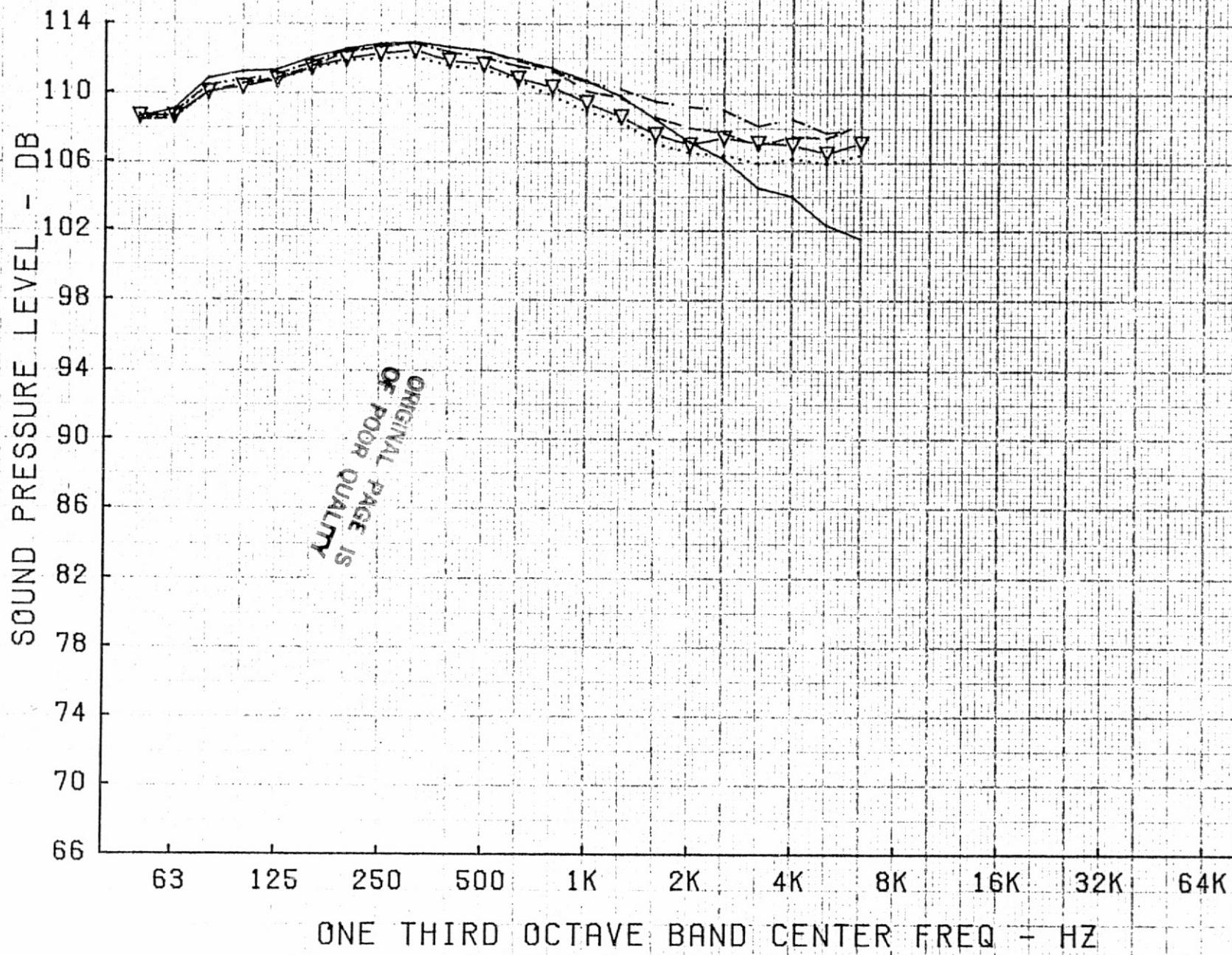
△ COND 8603 DEG 90

- COND 8303 DEG 90



NASA VSCE (NAS3-20061) TE 7 PT. 3

— COND 8203 DEG 120 — COND 8503 DEG 120 — COND 8303 DEG 120
 ... COND 8403 DEG 120 ▽ COND 8603 DEG 120



NASA VSCE (NAS3-20061) TE T PT. 3

— COND 8203 DEG 150
... COND 8403 DEG 150

-- COND 8503 DEG 150
▽ COND 8603 DEG 150

- COND 8303 DEG 150

SOUND PRESSURE LEVEL - DB

124
120
116
112
108
104
100
96
92
88
84
80
76

63 125 250 500 1K 2K 4K 8K 16K 32K 64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz

NASA VSCE (NAS3-20061) TE. 7 PT. 4

— COND 8204 DEG 90
... COND 8404 DEG 90

— COND 8504 DEG 90
▽ COND 8604 DEG 90

— COND 8304 DEG 90

SOUND PRESSURE LEVEL - DB

116
112
108
104
100
96
92
88
84
80
76
72
68

63 125 250 500 1K 2K 4K 8K 16K 32K 64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz

NASA VSCE (NAS3-20061)ITE. 1 PT. 4

— COND 8204 DEG 120
... COND 8404 DEG 120— COND 8504 DEG 120
▽ COND 8604 DEG 120

— COND 8304 DEG 120

SOUND PRESSURE LEVEL - DB

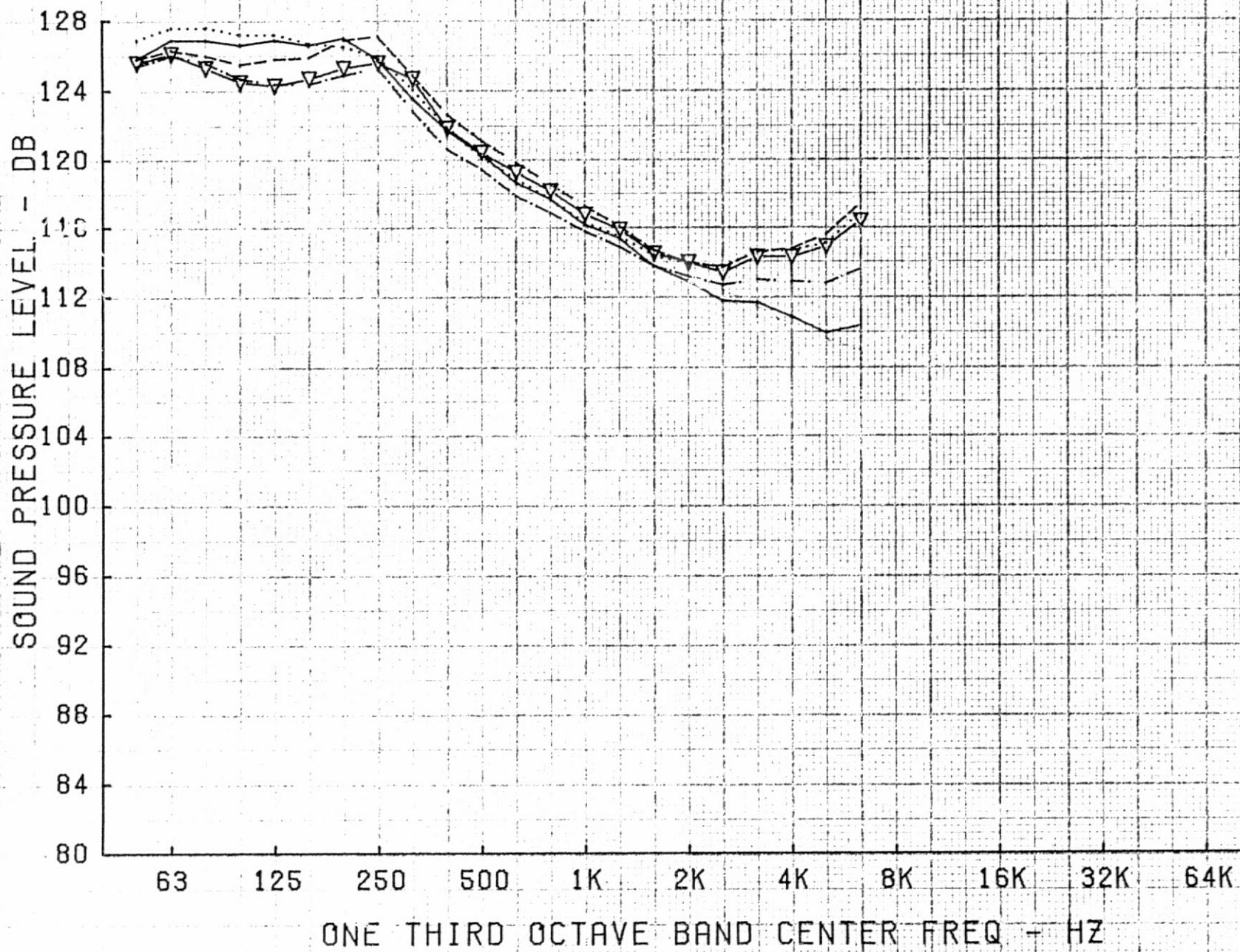
118
114
110
106
102
98
94
90
86
82
78
74
70

63 125 250 500 1K 2K 4K 8K 16K 32K 64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz

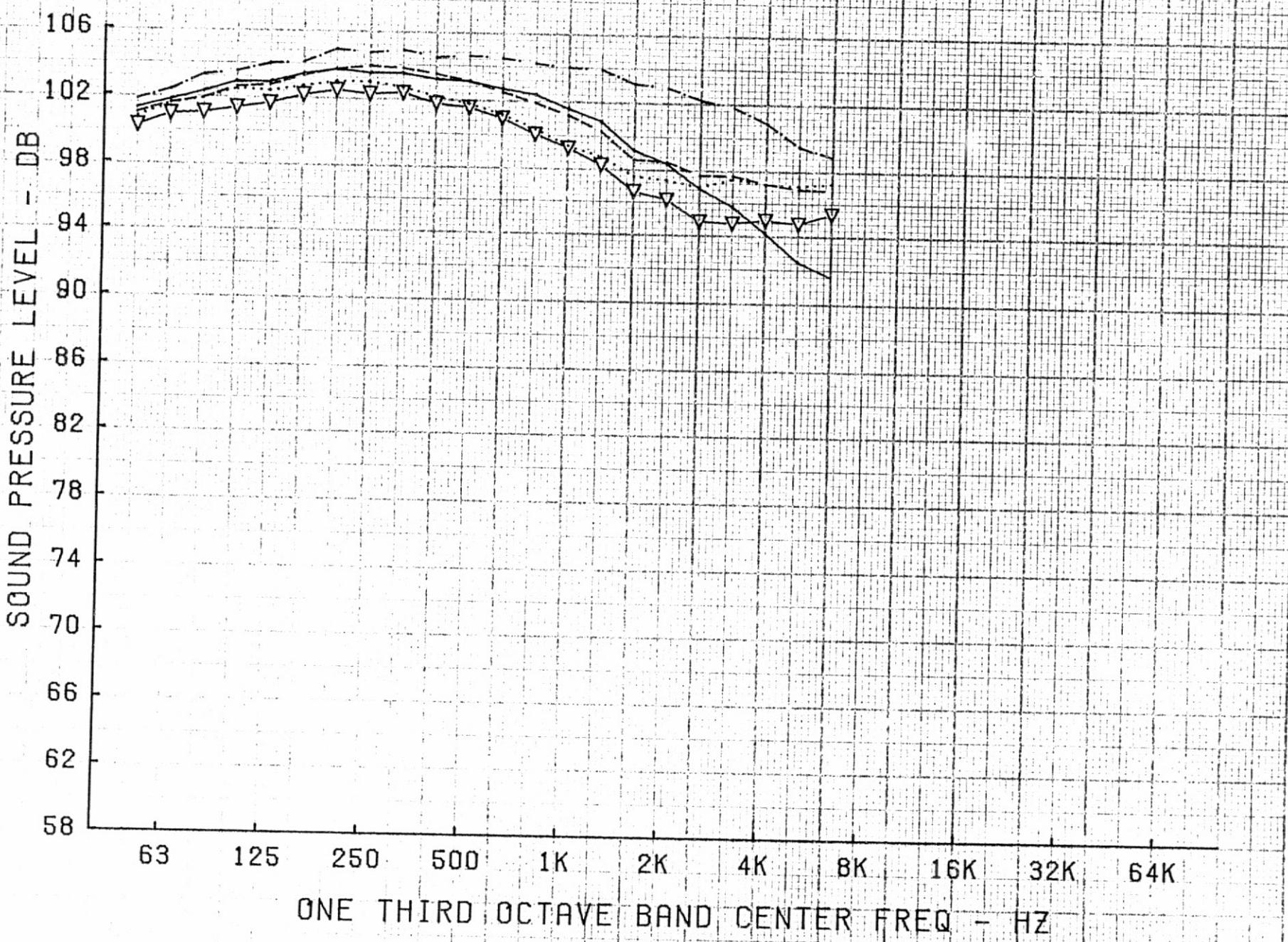
NASA VSCE (NAS3-20061) TE [PT. 4

— COND 8204 DEG 150 -- COND 8504 DEG 150 - COND 8304 DEG 150
... COND 8404 DEG 150 ▽ COND 8604 DEG 150



NASA VSCE (NAS3-20061) TE, PT. 5

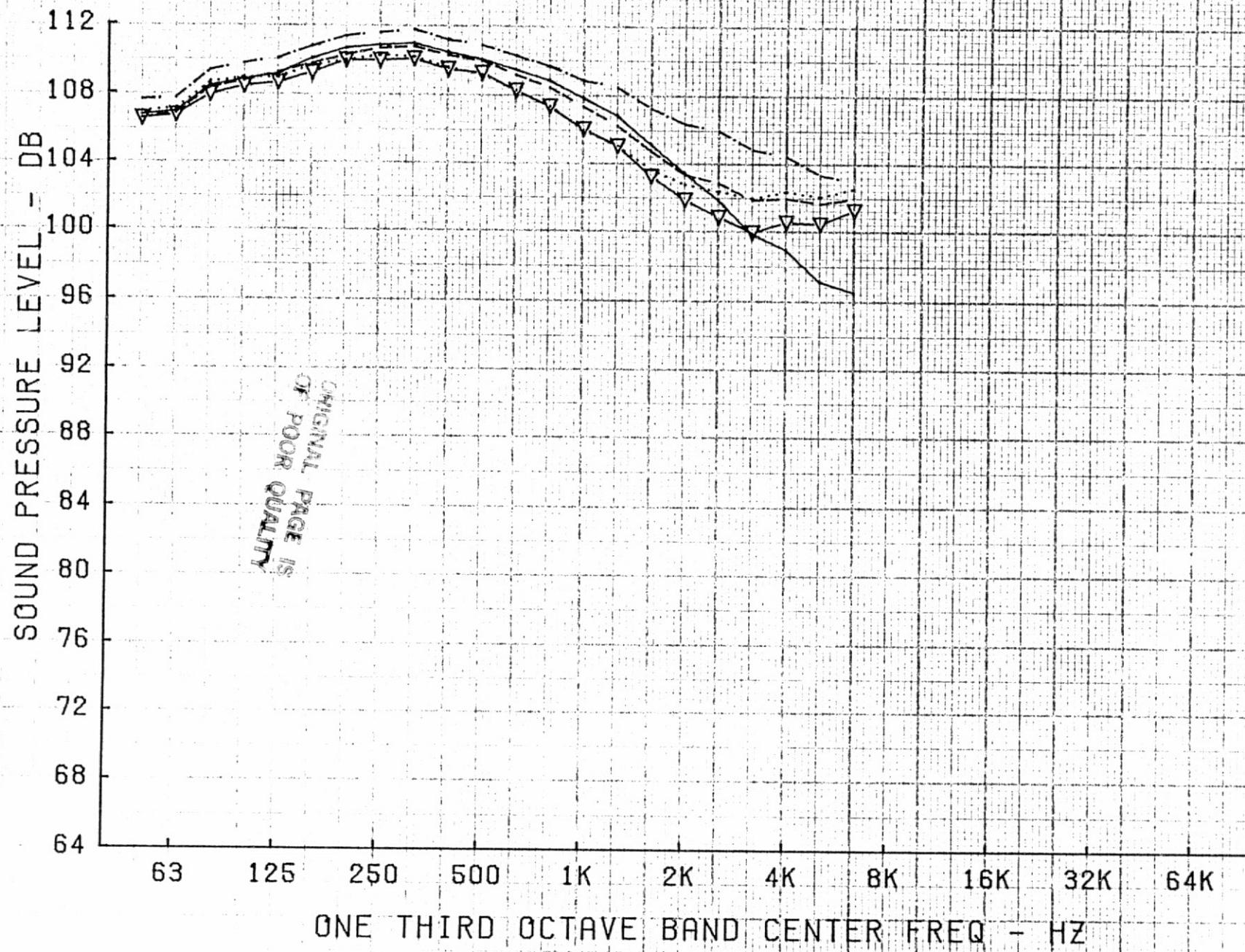
— COND 8205 DEG 90 - - COND 8505 DEG 90 - - COND 8305 DEG 90
 ... COND 8405 DEG 90 V COND 8605 DEG 90



B-14

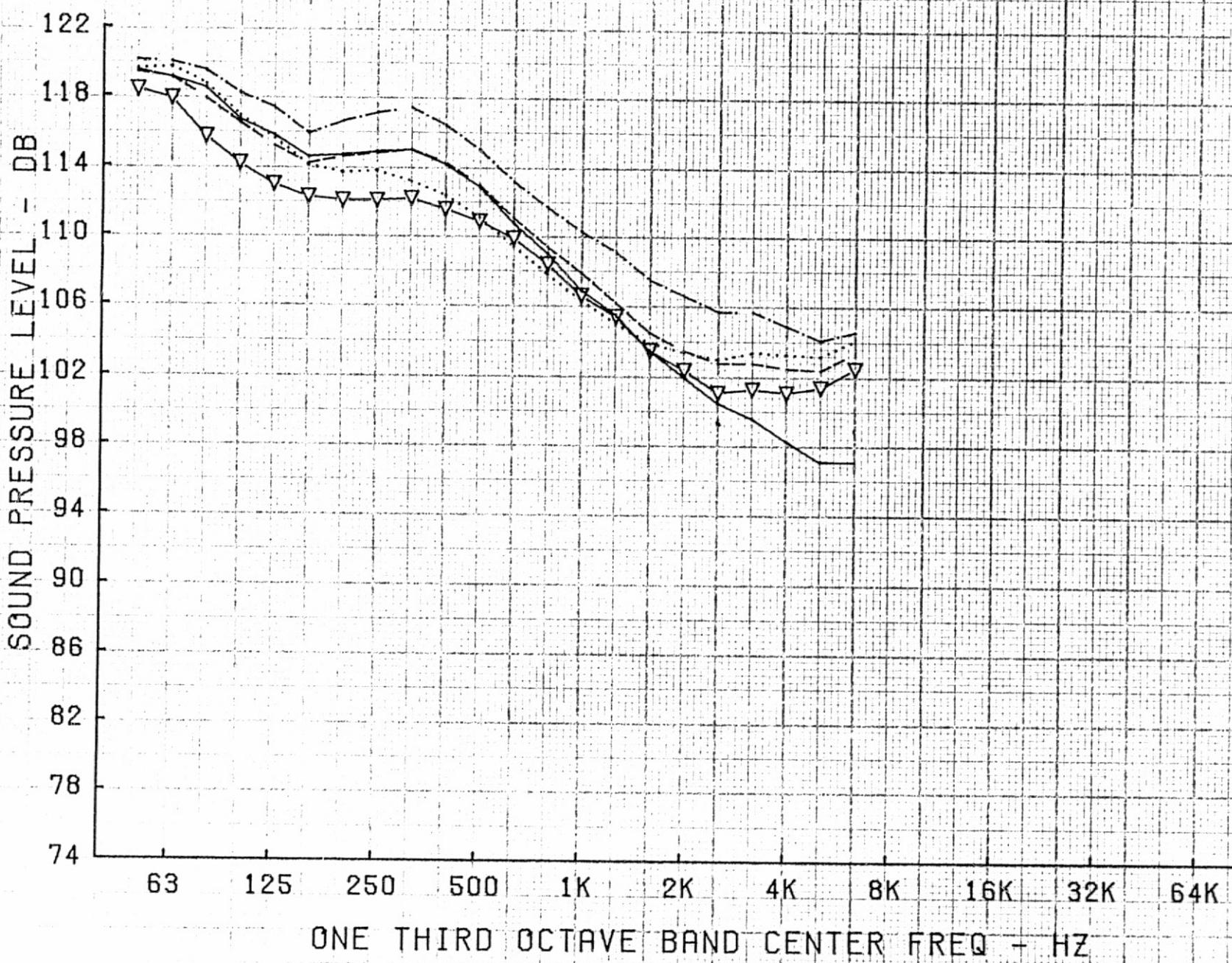
NASA VSCE (NAS3-20061) TE. I PT. 5

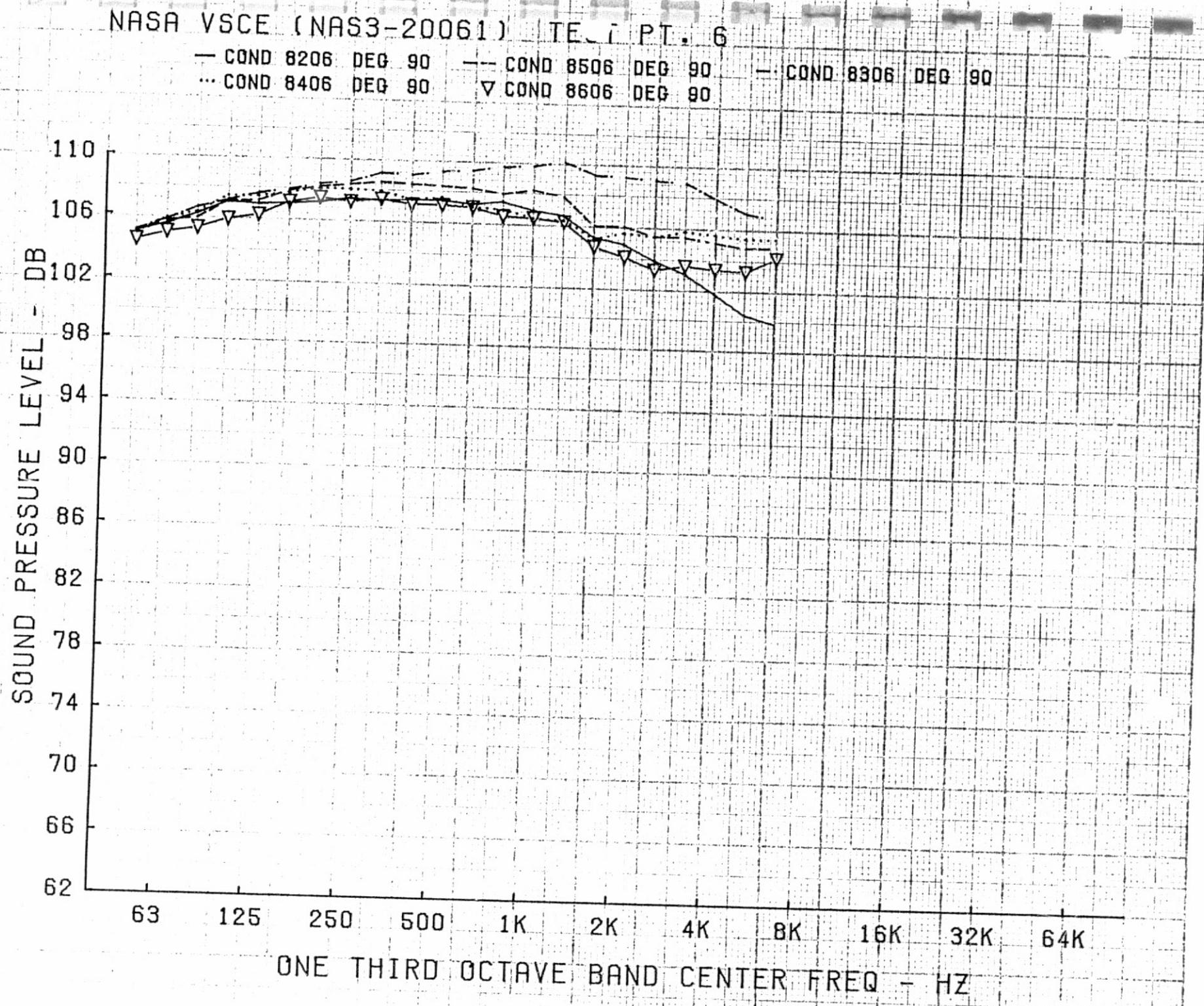
— COND 8205 DEG 120 - - COND 8505 DEG 120 - COND 8305 DEG 120
... COND 8405 DEG 120 V COND 8605 DEG 120



NASA VSCE (NAS3-20061) TE PT. 5

— COND 8205 DEG 150 — COND 8505 DEG 150 — COND 8305 DEG 150
… COND 8405 DEG 150 ▽ COND 8605 DEG 150





NASA VSCE (NAS3-20061) TE. I PT. 6

— COND 8206 DEG 120
... COND 8406 DEG 120

-- COND 8506 DEG 120
▽ COND 8606 DEG 120

- COND 8306 DEG 120

SOUND PRESSURE LEVEL - DB

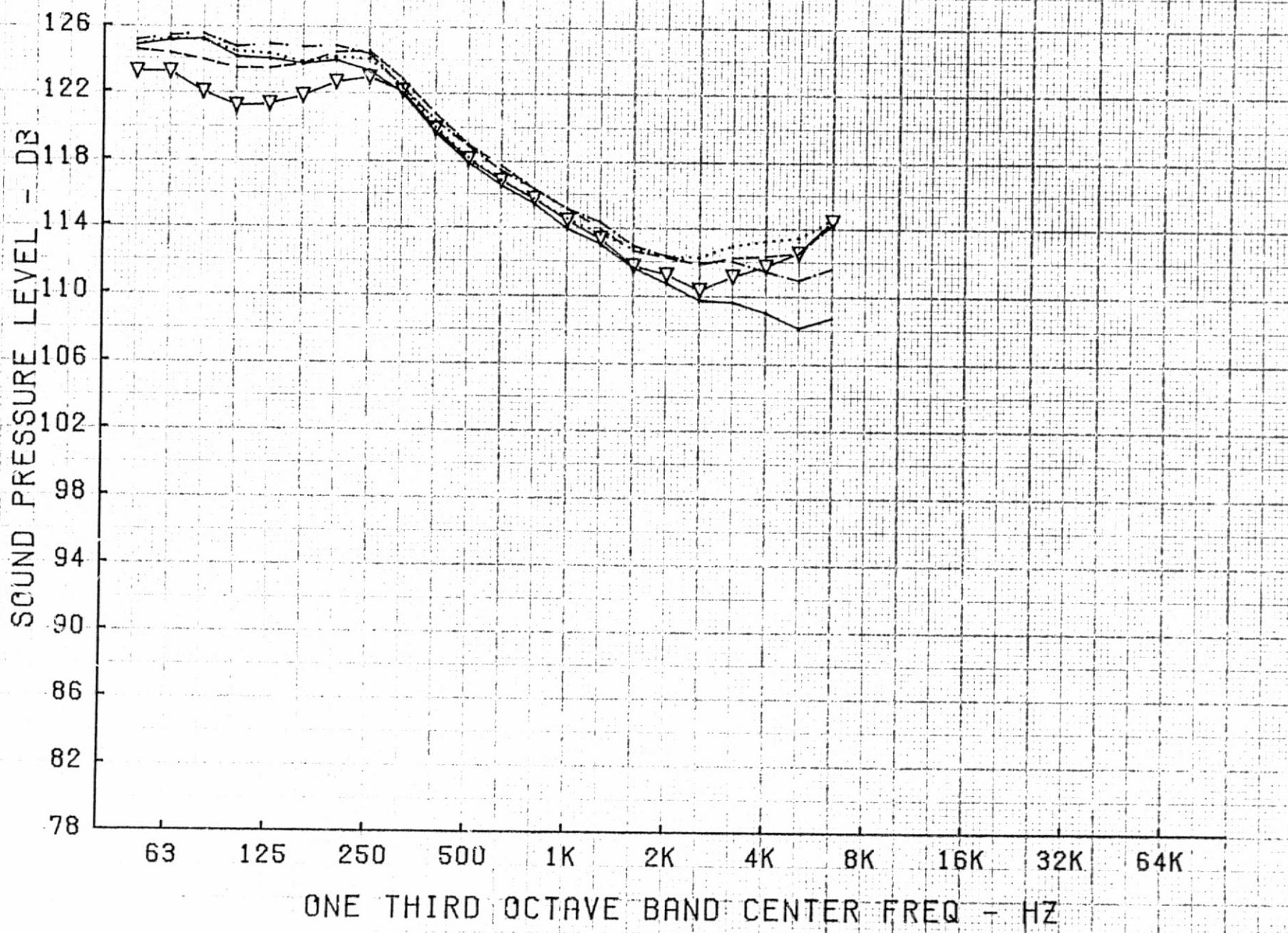
118
114
110
106
102
98
94
90
86
82
78
74
70

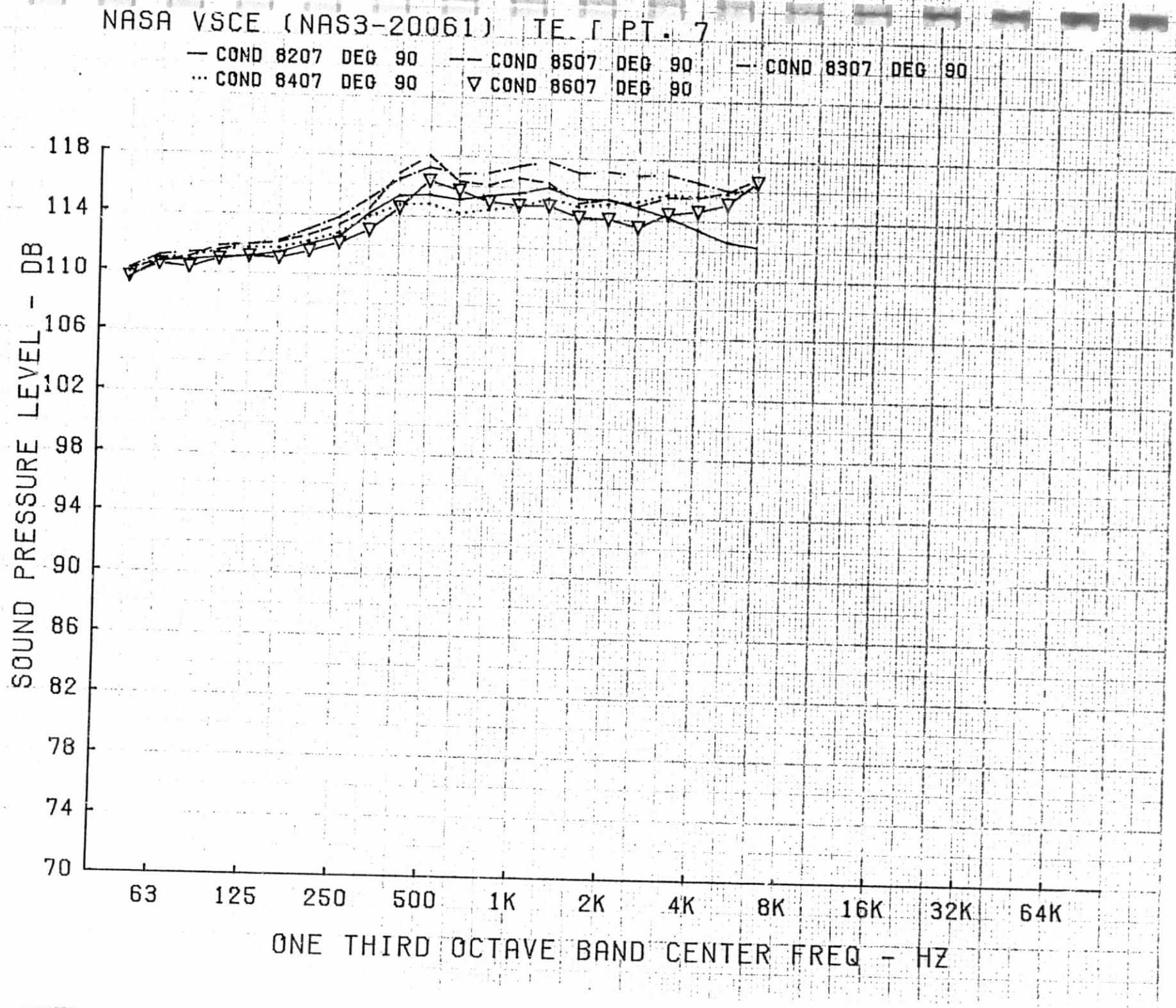
63 125 250 500 1K 2K 4K 8K 16K 32K 64K

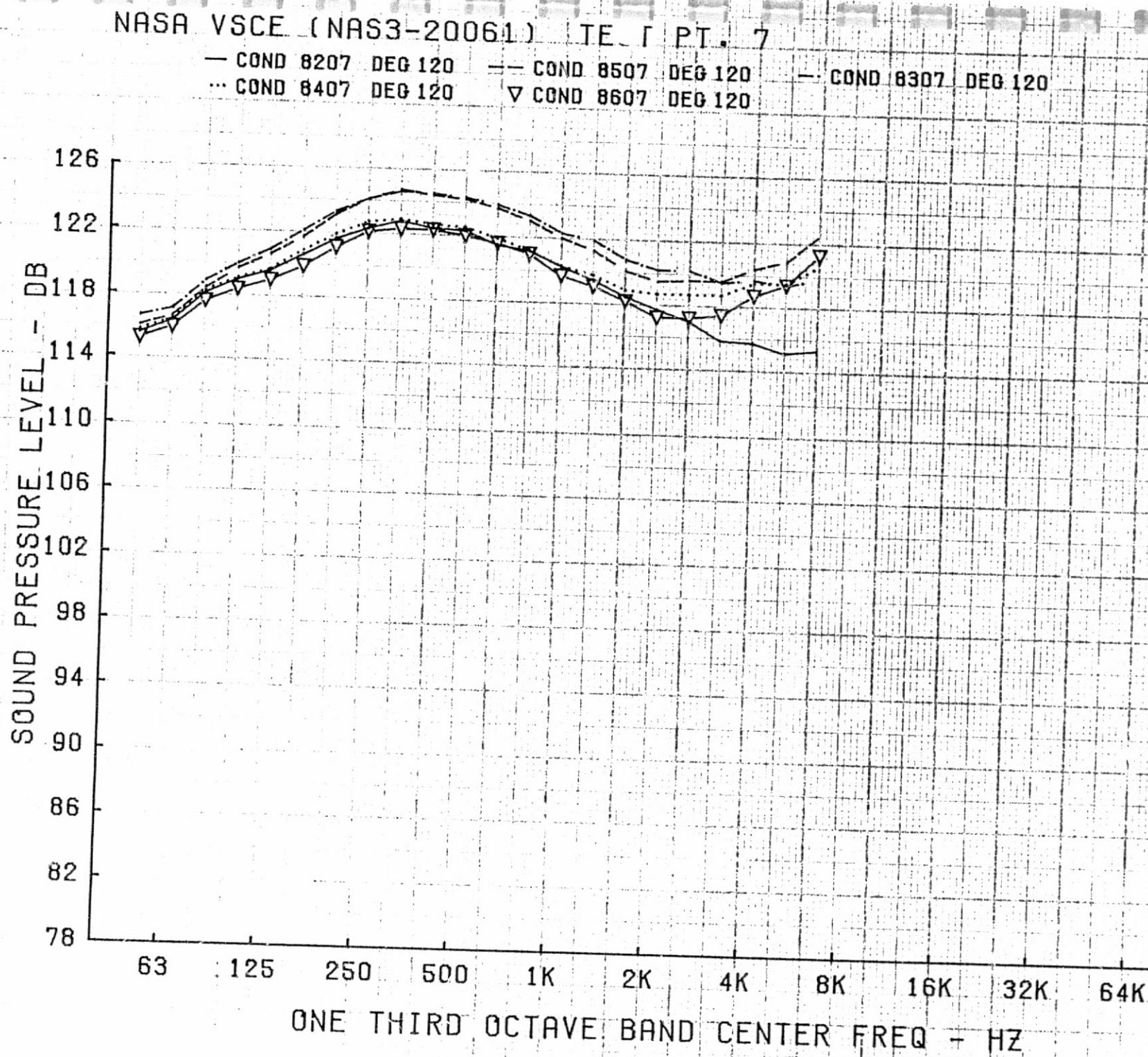
ONE THIRD OCTAVE BAND CENTER FREQ - Hz

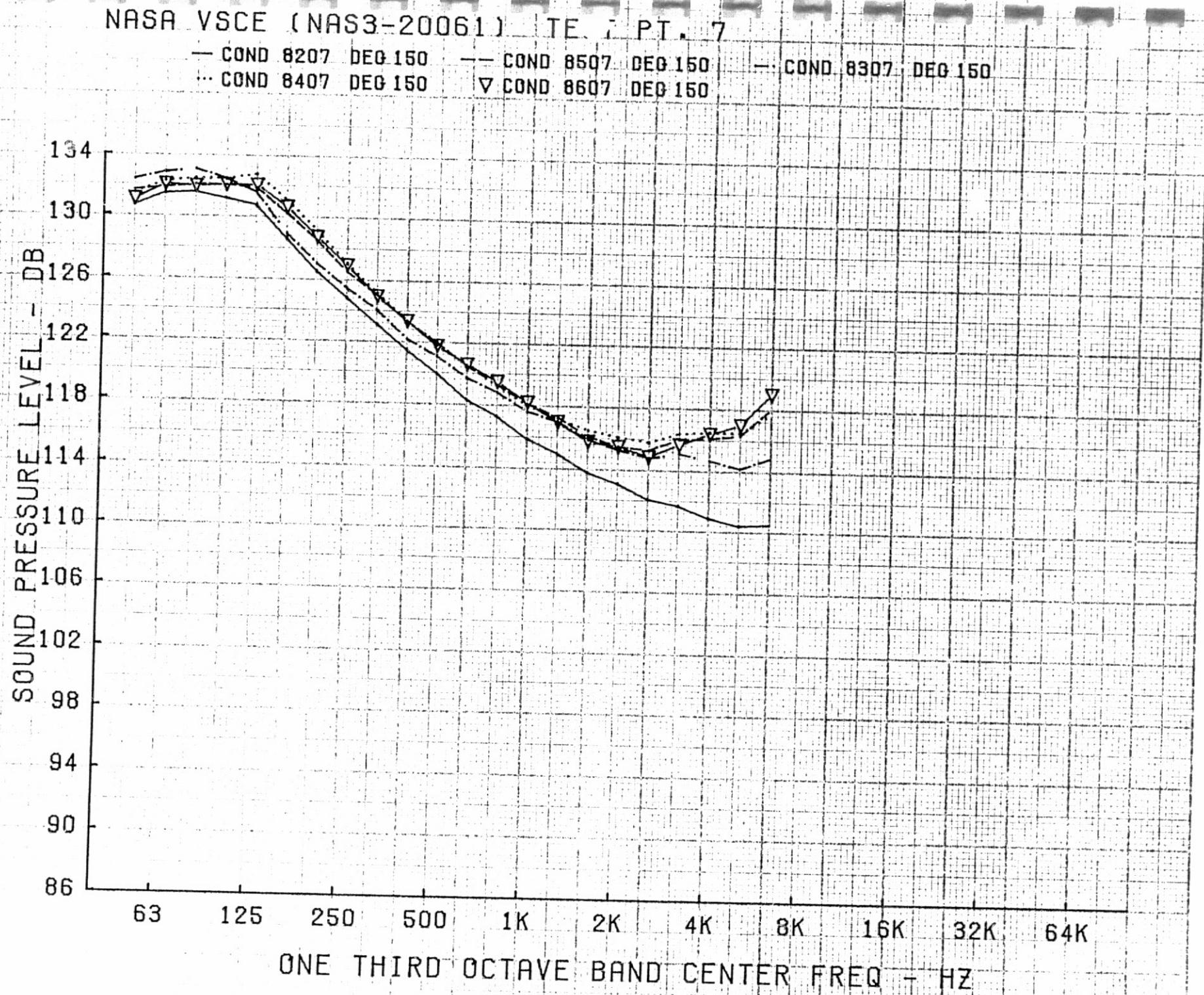
NASA VSCE (NAS3-20061) TEST PT. 6

— COND 8206 DEG 150 - - COND 8506 DEG 150 - · COND 8306 DEG 150
... COND 8406 DEG 150 ▽ COND 8606 DEG 150



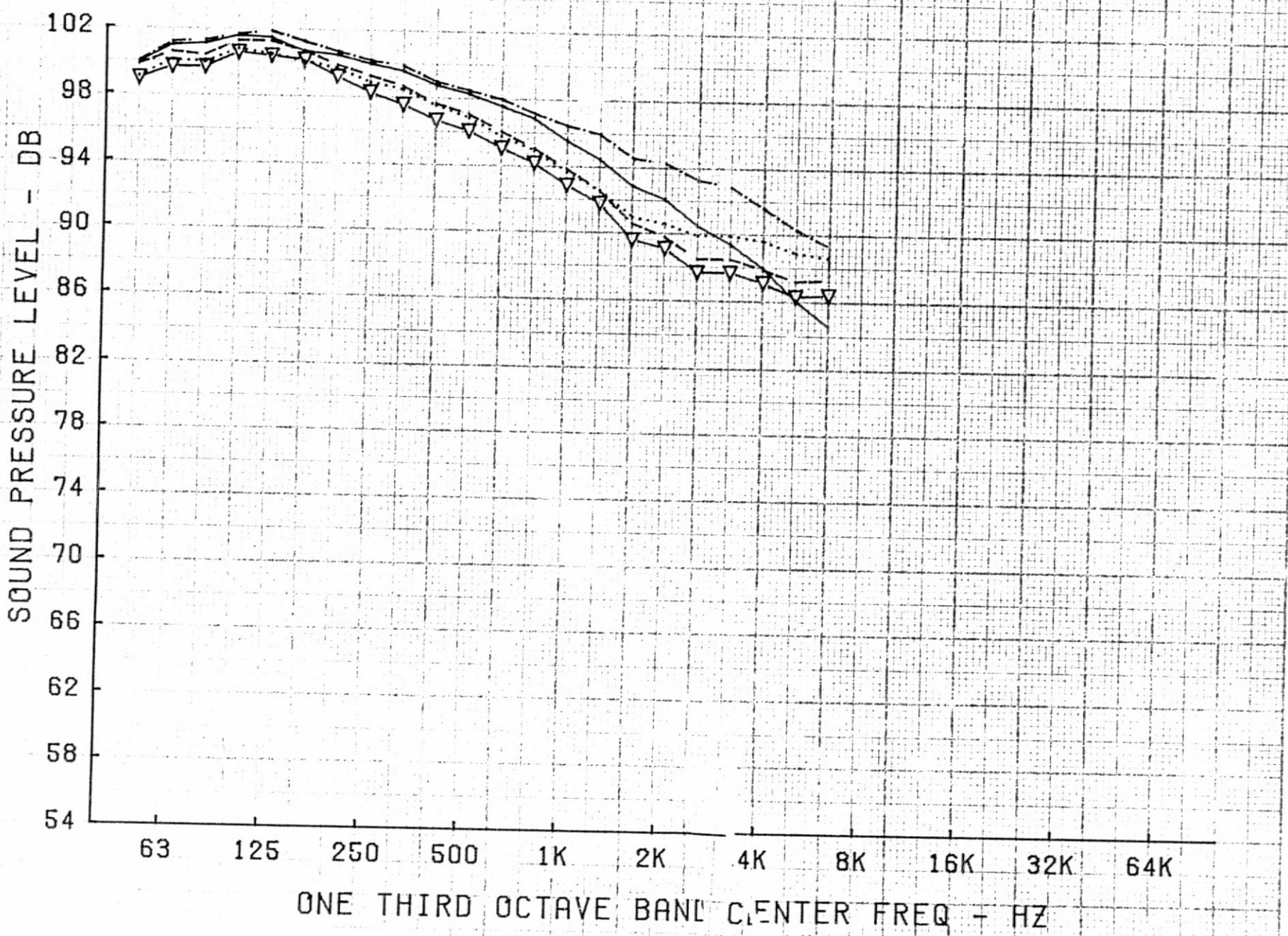






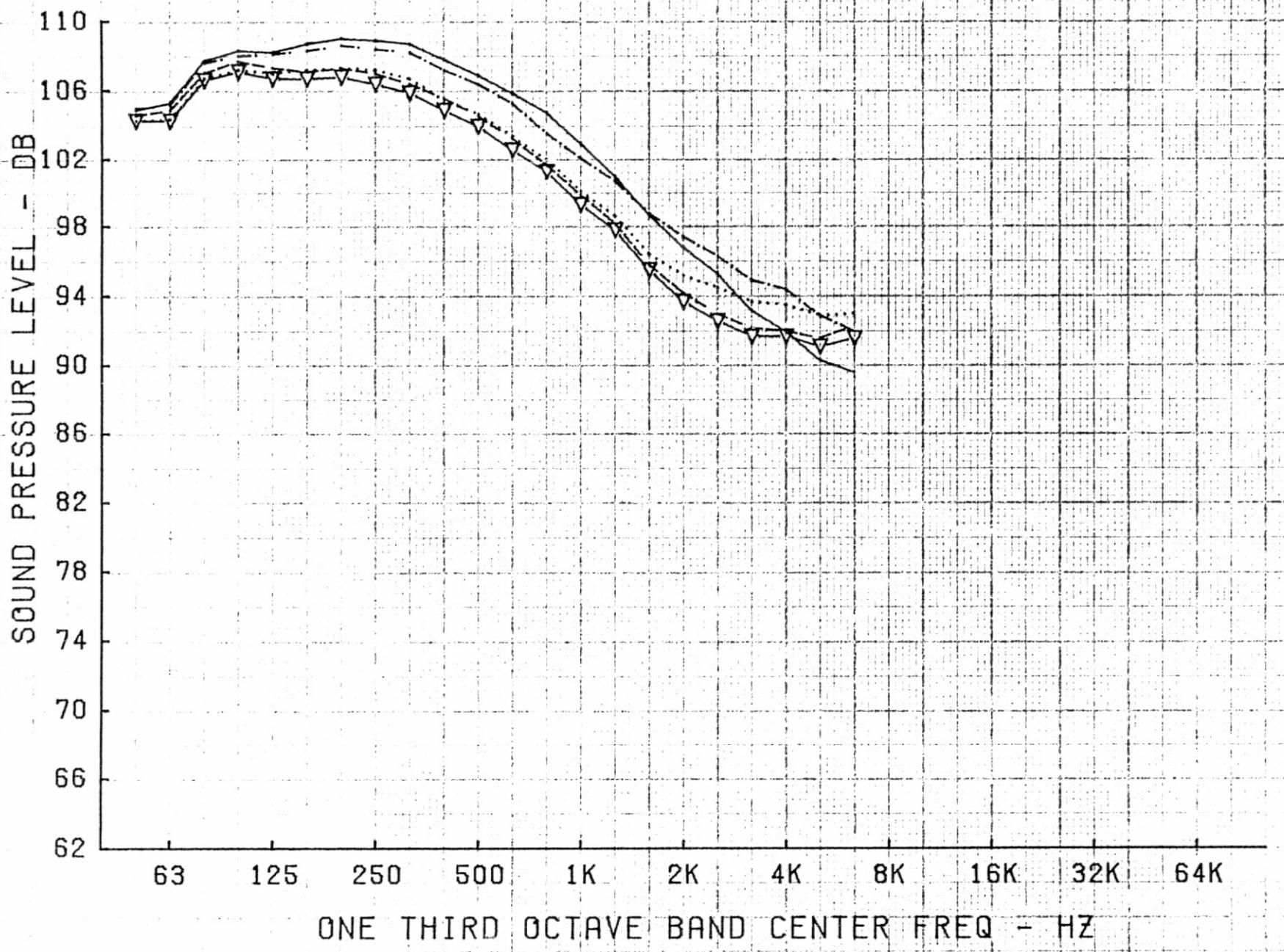
NASA VSCE (NAS3-20061) TE PPT. 8

— COND 8208 DEG 90 - - COND 8508 DEG 90 - . COND 8308 DEG 90
.. COND 8408 DEG 90 ▽ COND 8608 DEG 90



NASA VSCE (NAS3-20061) TE Γ PT. 8

— COND 8208 DEG 120 -- COND 8508 DEG 120 - COND 8308 DEG 120
... COND 8408 DEG 120 ▽ COND 8608 DEG 120



NASA VSCE (NAS3-20061) TE I PT. 8

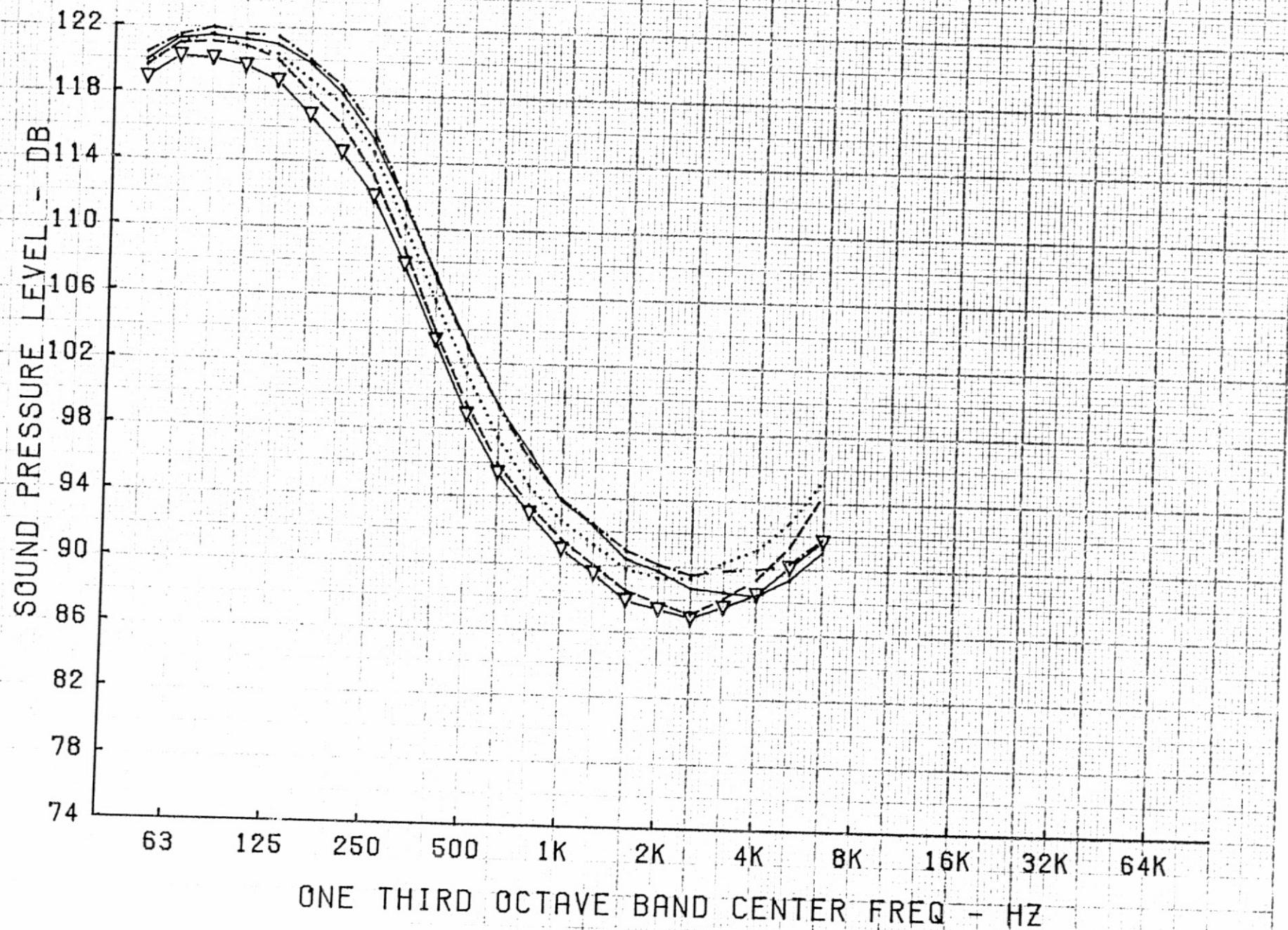
— COND 8208 DEG 150

... COND 8408 DEG 150

— COND 8508 DEG 150

▽ COND 8608 DEG 150

— COND 8308 DEG 150



NASA VSCE (NAS3-20061) TE PT 9

— COND 8209 DEG 90
... COND 8409 DEG 90

-- COND 8509 DEG 90
▽ COND 8609 DEG 90

- COND 8309 DEG 90

106

102

98

94

90

86

82

78

74

70

66

62

58

SOUND PRESSURE LEVEL - DB

63

125

250

500

1K

2K

4K

8K

16K

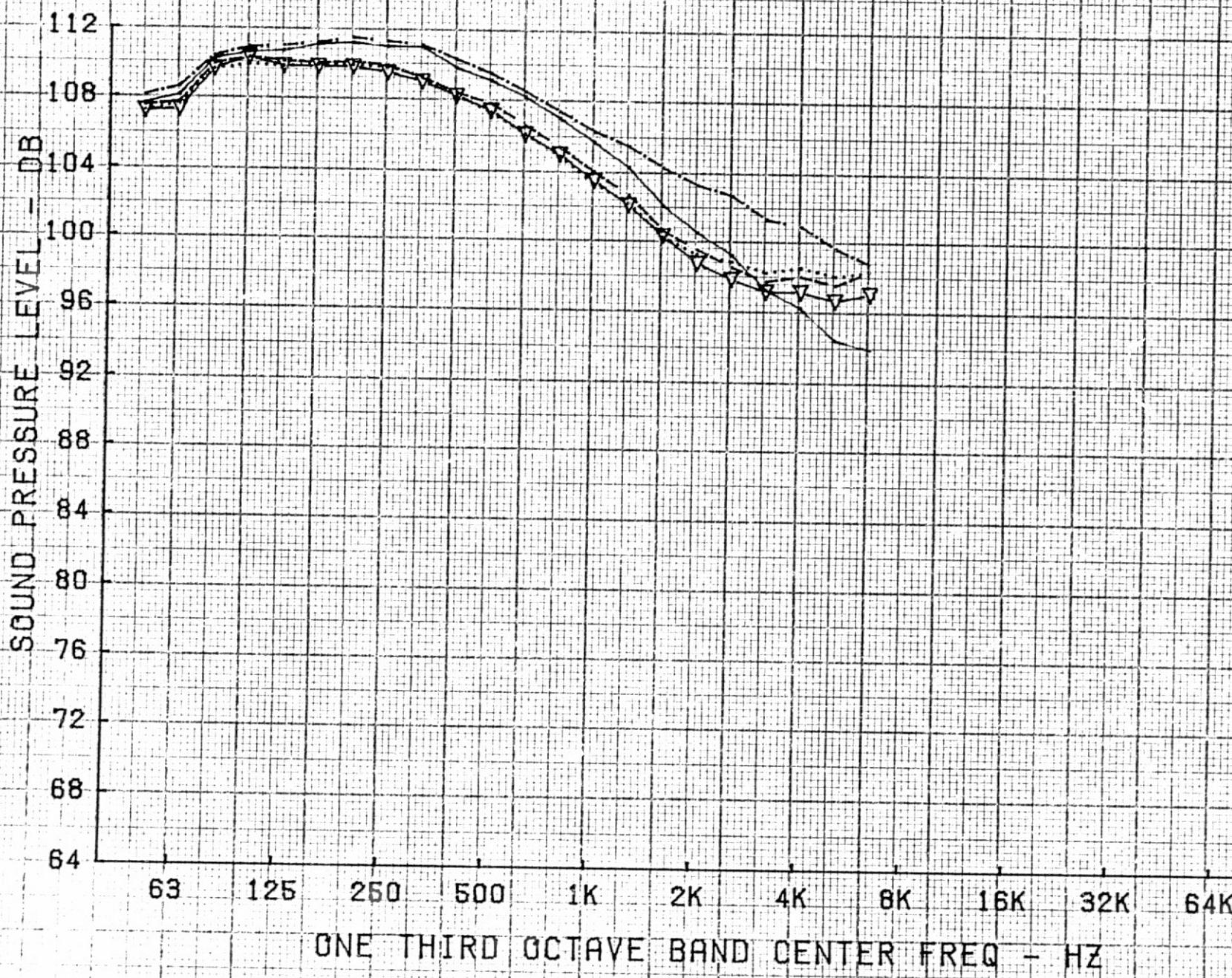
32K

64K

CNE THIRD OCTAVE BAND CENTER FREQ - Hz

NASA VSCE (NAS3-20061) TE I PT. 9

— COND 8209 DEG 120 -- COND 8509 DEG 120 -· COND 8309 DEG 120
... COND 6409 DEG 120 V COND 8609 DEG 120



NASA VSCE (NAS3-20061) TE PT. 9

— COND 8209 DEG 150
... COND 8409 DEG 150

-- COND 8509 DEG 150
▽ COND 8609 DEG 150

-- COND 8309 DEG 150

SOUND PRESSURE LEVEL - DB

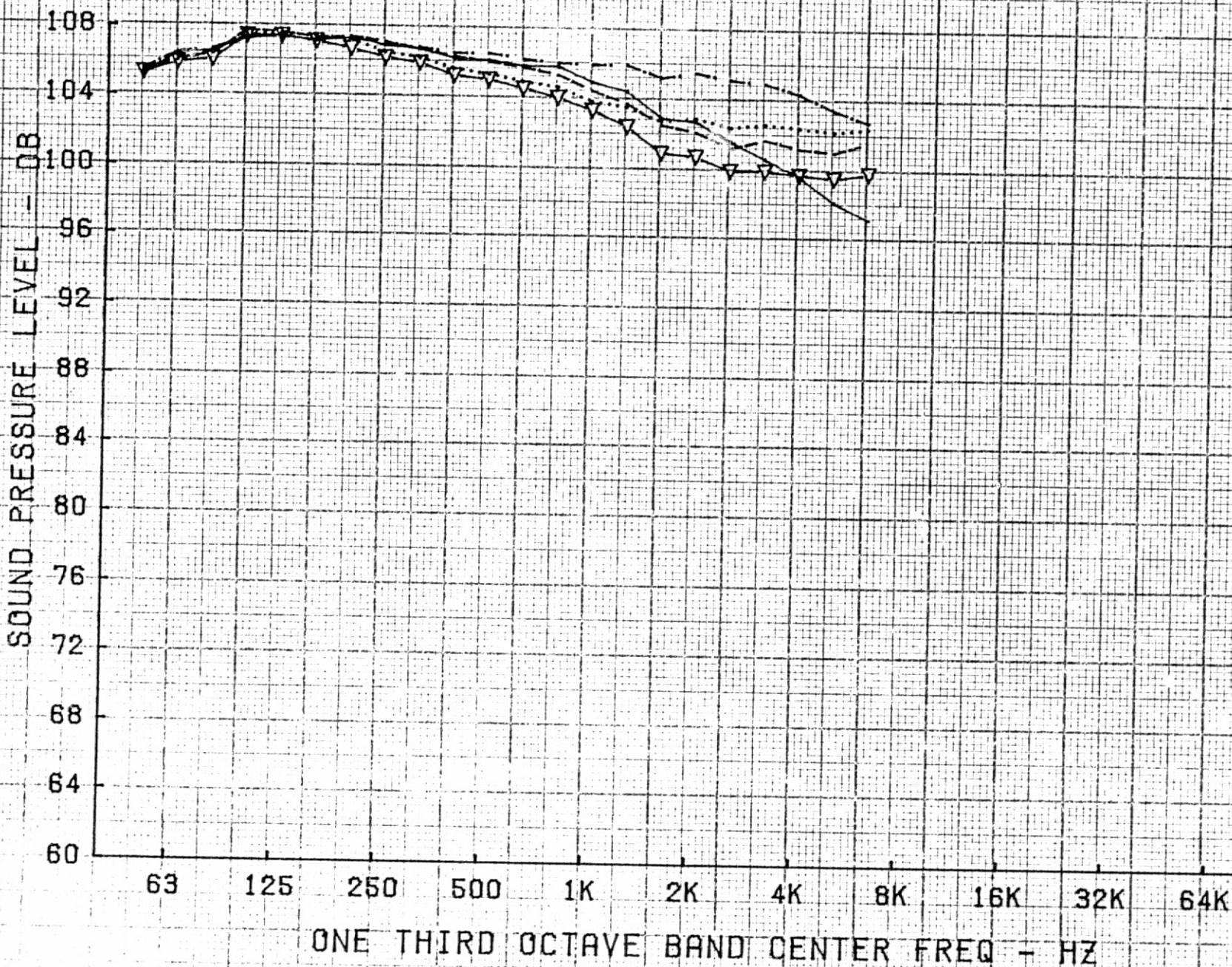
126
122
118
114
110
106
102
98
94
90
86
82
78

63 125 250 500 1K 2K 4K 8K 16K 32K 64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz

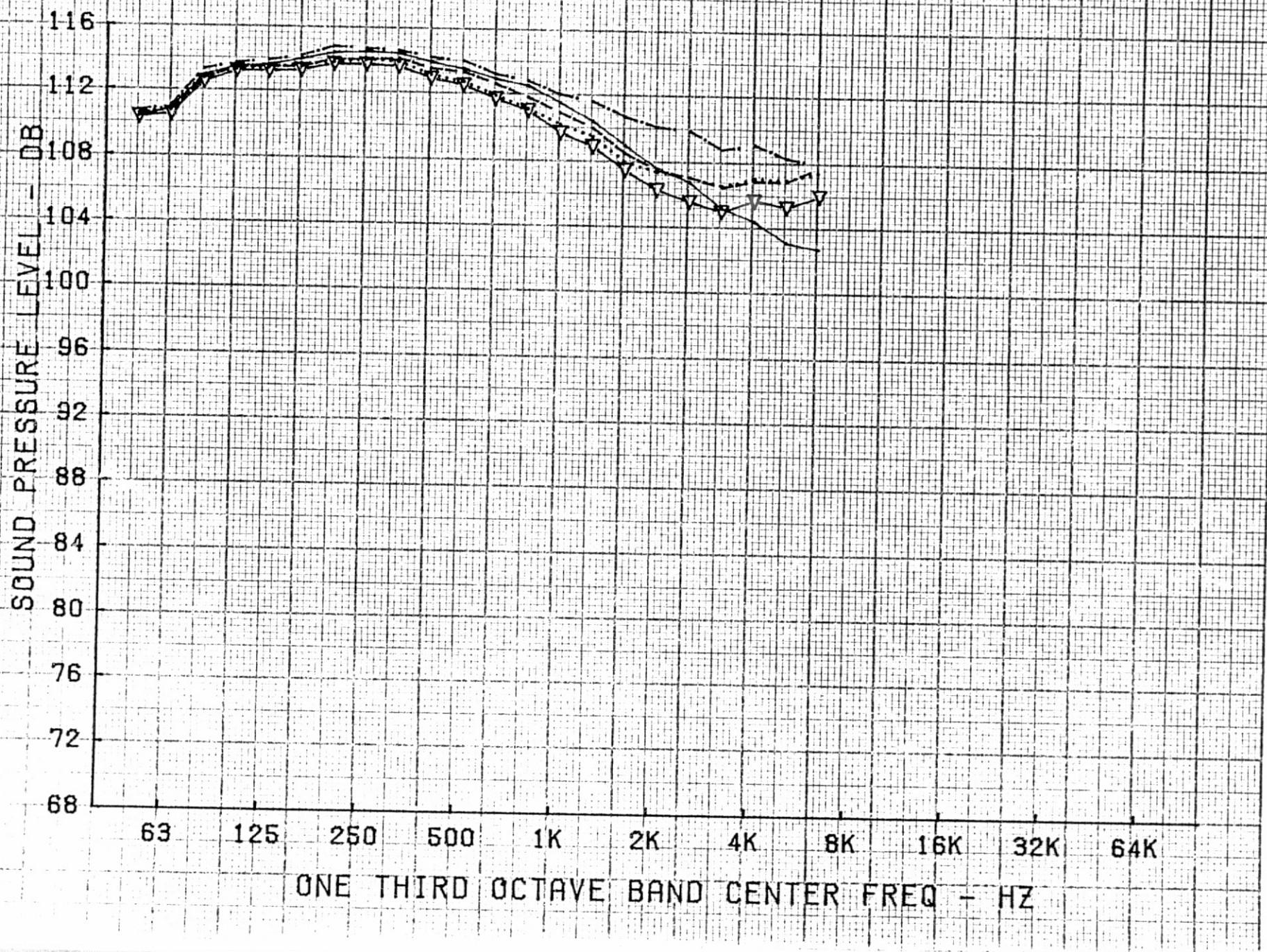
NASA VSCE (NAS3-20061) TE : PT. 10

— COND 8210 DEG 90 - COND 8510 DEG 90 = COND 8310 DEG 90
... COND 8410 DEG 90 ▽ COND 8610 DEG 90



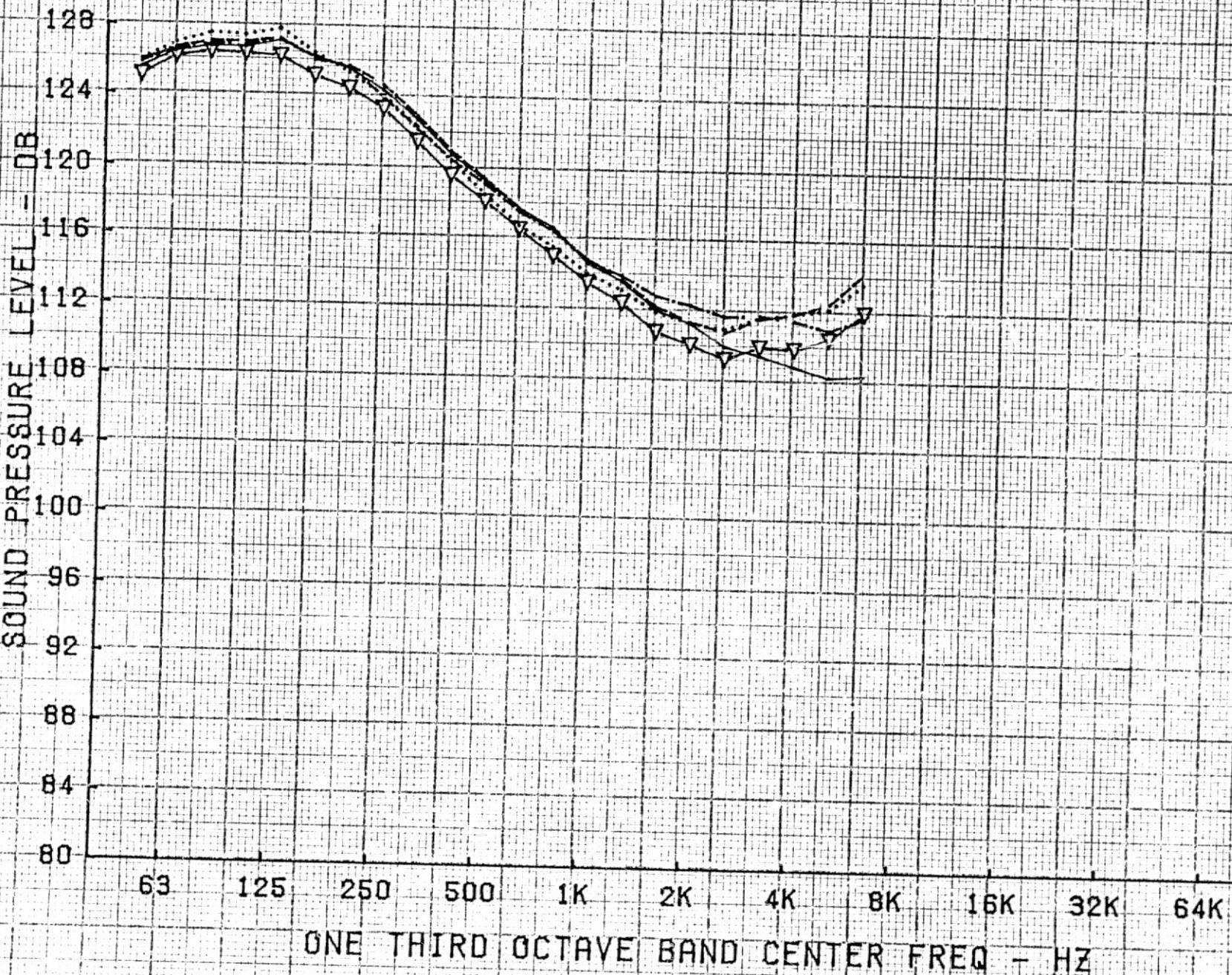
NASA VSCE (NAS3-20061) TF 1 PT. 10

— COND 8210 DEG 120 -- COND 8510 DEG 120
... COND 8410 DEG 120 V COND 8610 DEG 120



NASA VSCE (NAS3-20061) TE PT. 10

— COND 8210 DEG 150 - COND 8510 DEG 150 - COND 8310 DEG 150
... COND 8410 DEG 150 ▽ COND 8610 DEG 150



NASA VSCE (NAS3-20061) TE : PT. 11

— COND 8211 DEG 90
... COND 8411 DEG 90-- COND 8511 DEG 90
▽ COND 8611 DEG 90

— COND 8311 DEG 90

112

108

104

100

96

92

88

84

80

76

72

68

64

SOUND PRESSURE LEVEL - DB

63

125

250

500

1K

2K

4K

8K

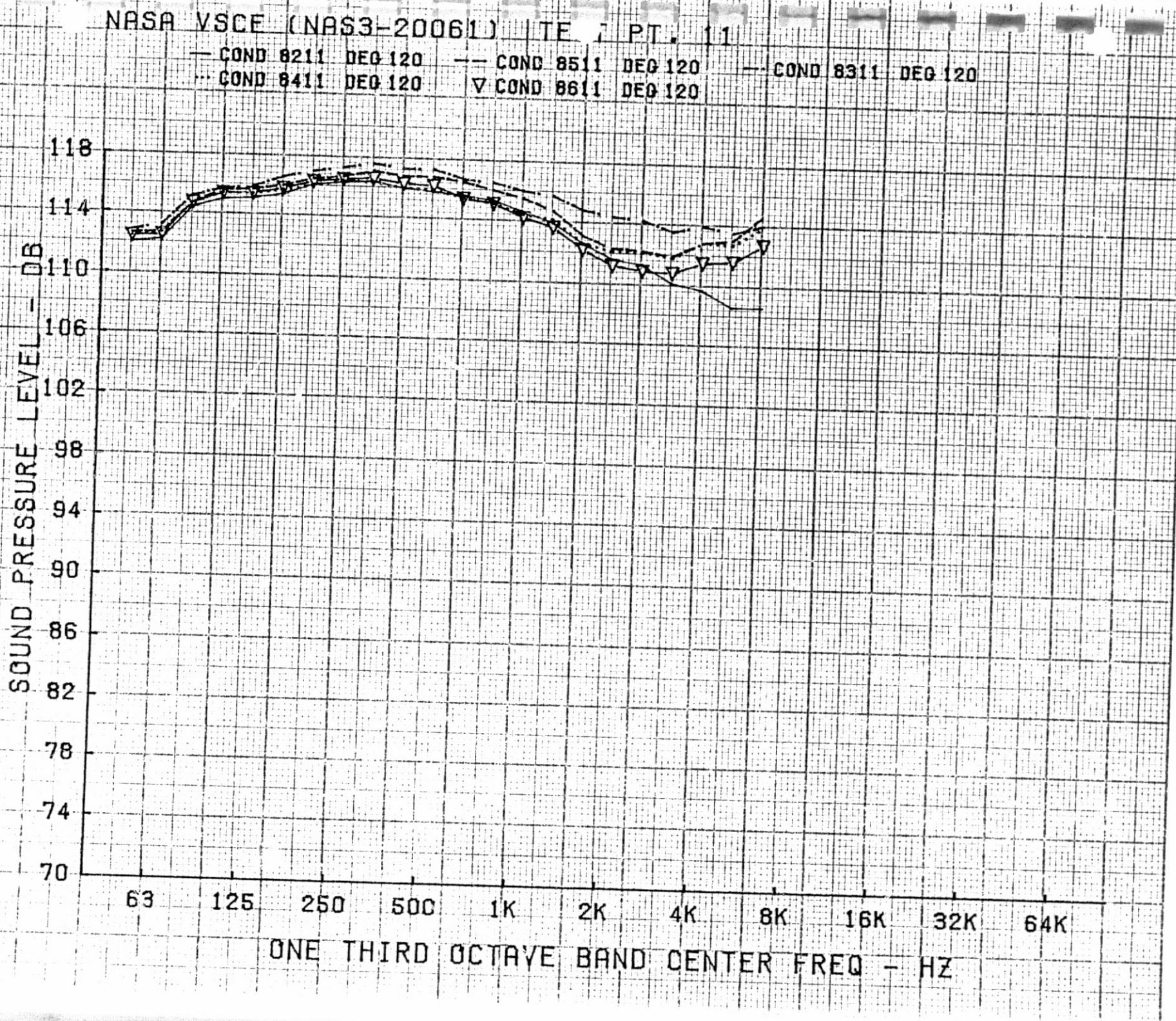
16K

32K

64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz

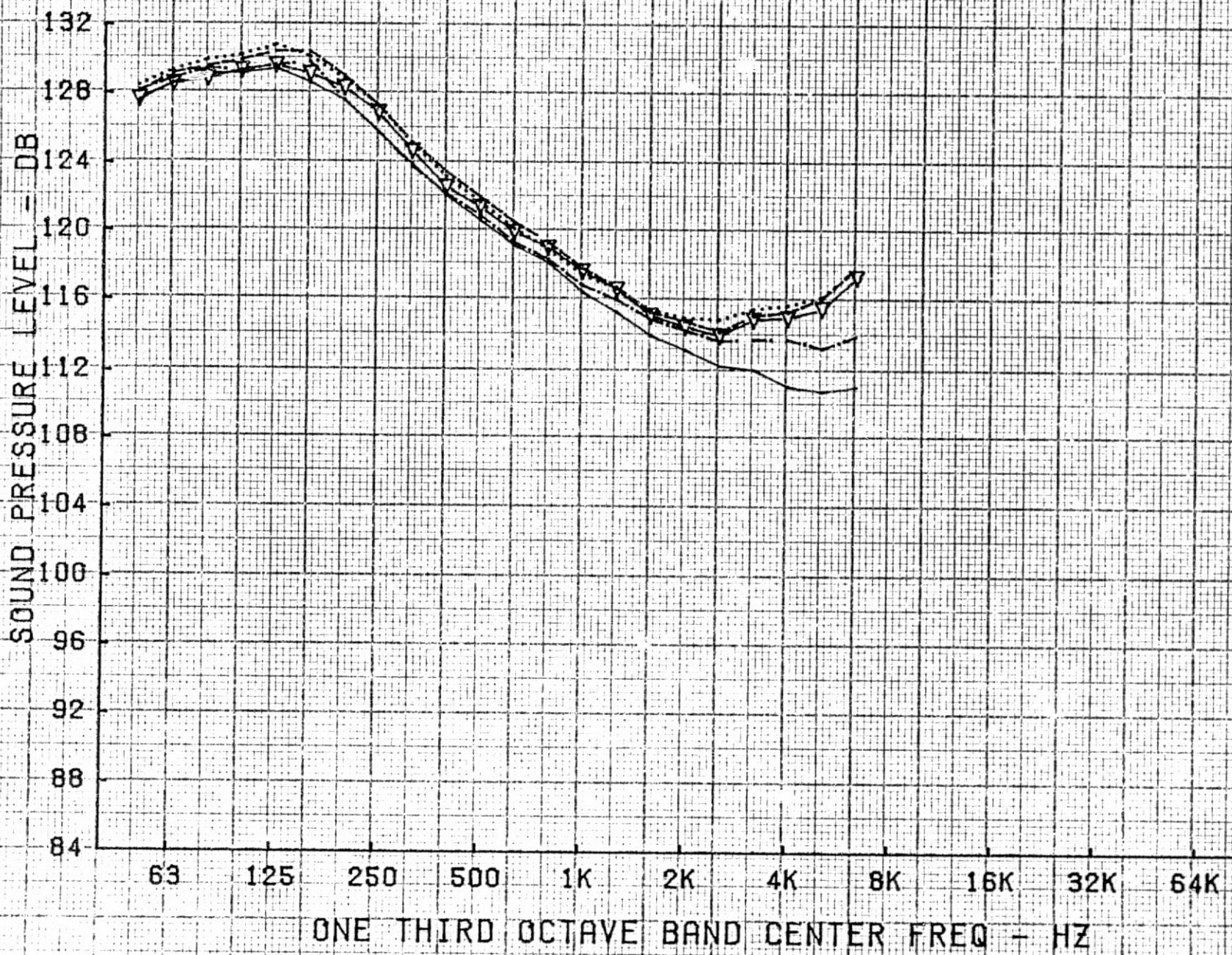
1E-8

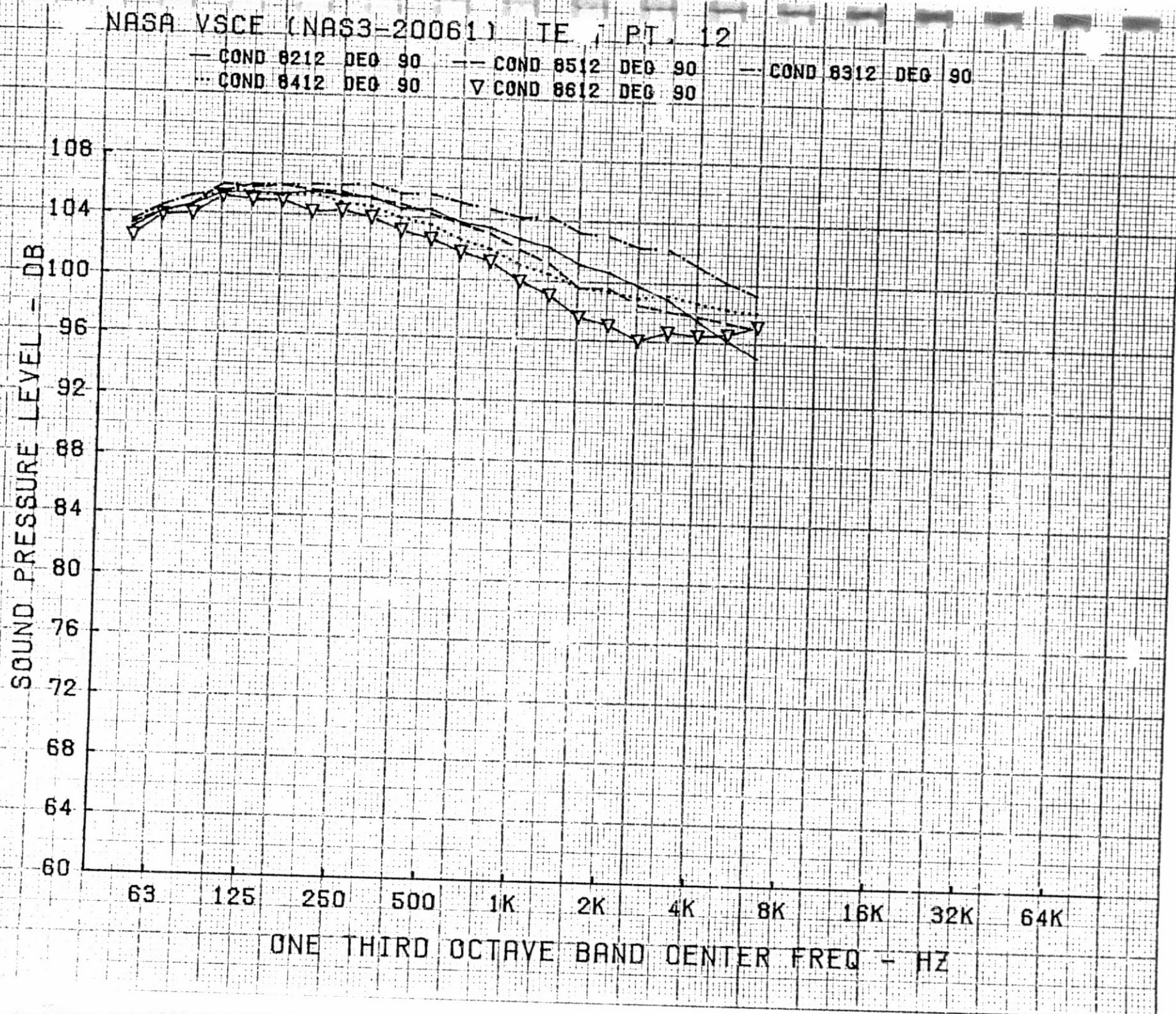


NASA VSCE (NAS3-20061) TE : PT. 11

— COND 8211 DEG 150 --- COND 8511 DEG 150 --- COND 8911 DEG 150
... COND 8411 DEG 150 ▽ COND 8611 DEG 150

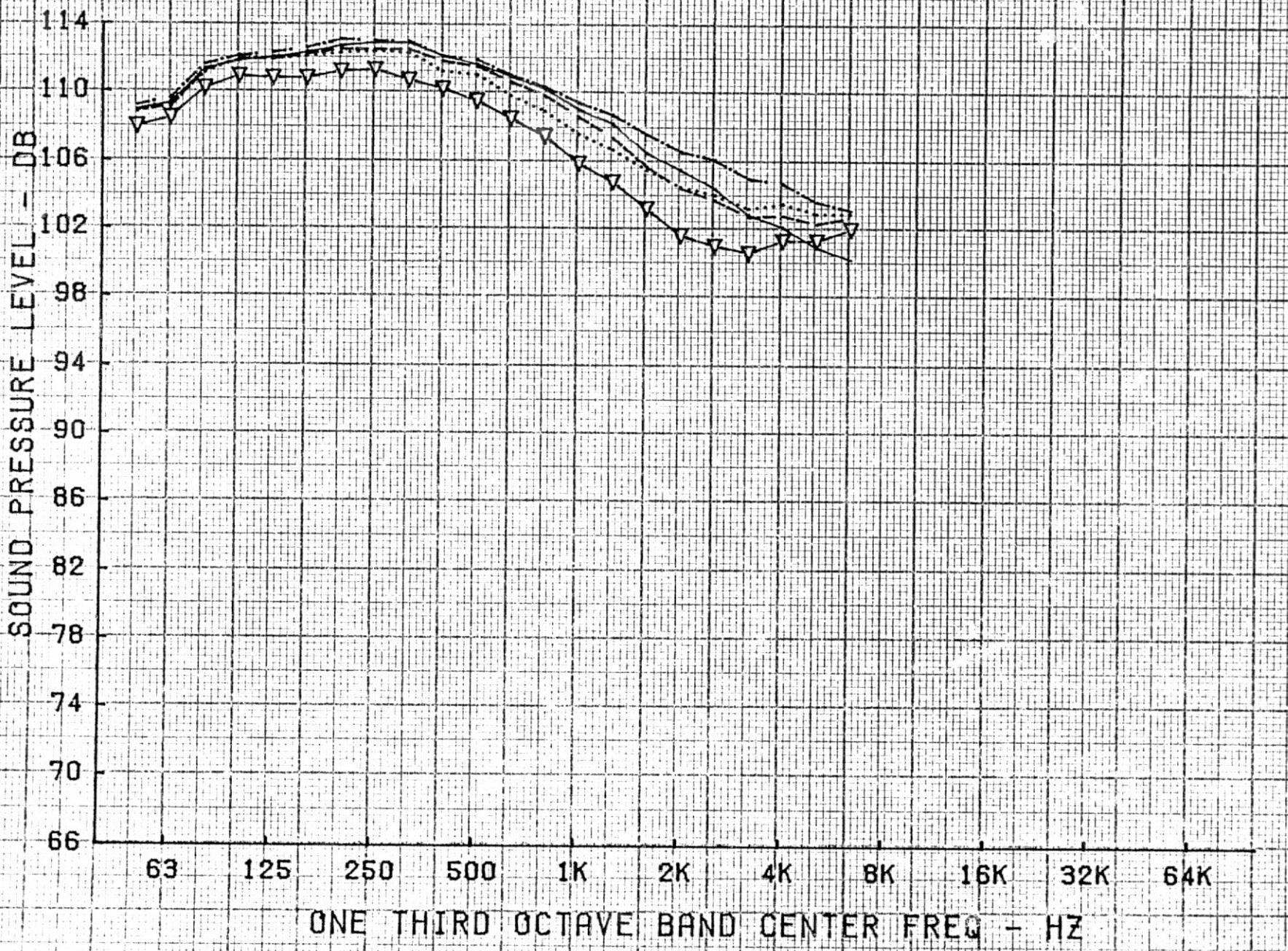
EE-B





NASA VSCE (NAS3-20061) TE 1 PT 12

— COND 8212 DEG 120 - COND 8512 DEG 120 - COND 8312 DEG 120
... COND 8412 DEG 120 V COND 8612 DEG 120

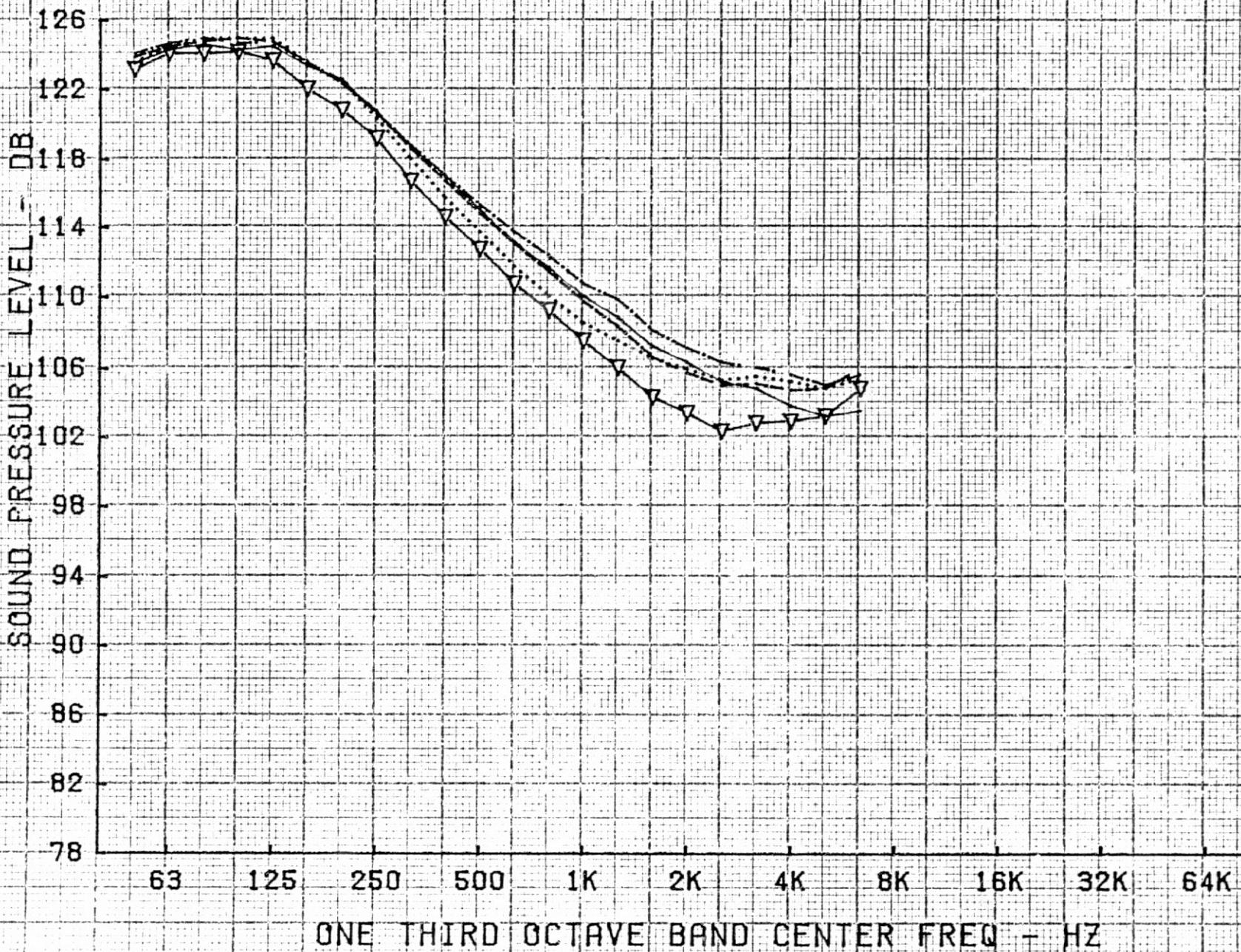


NASA VSCE (NAS3-20061) TE 1 PT. 12

— COND 8212 DEG 150
... COND 8412 DEG 150

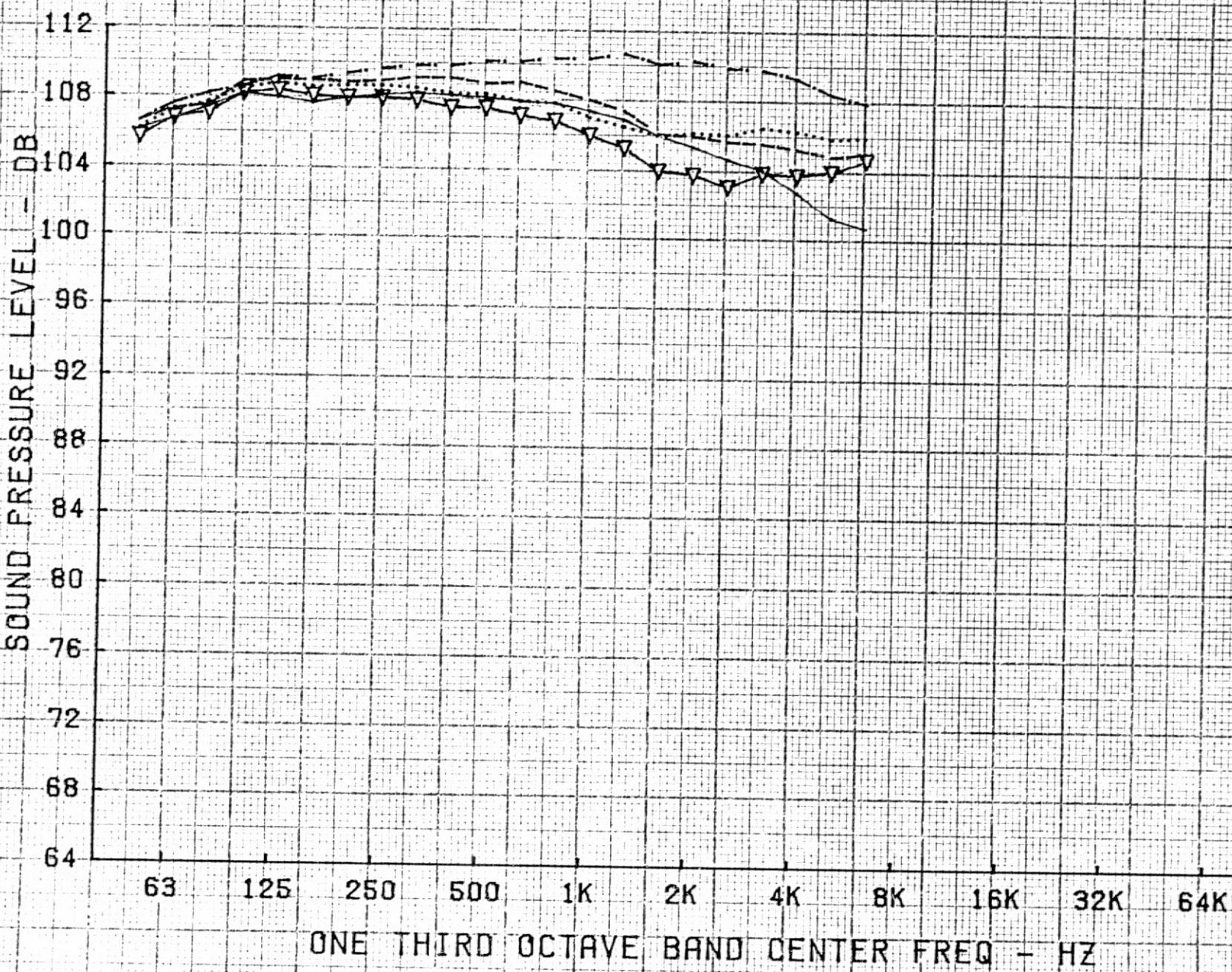
-- COND 8512 DEG 150
▽ COND 8612 DEG 150

— COND 8312 DEG 150



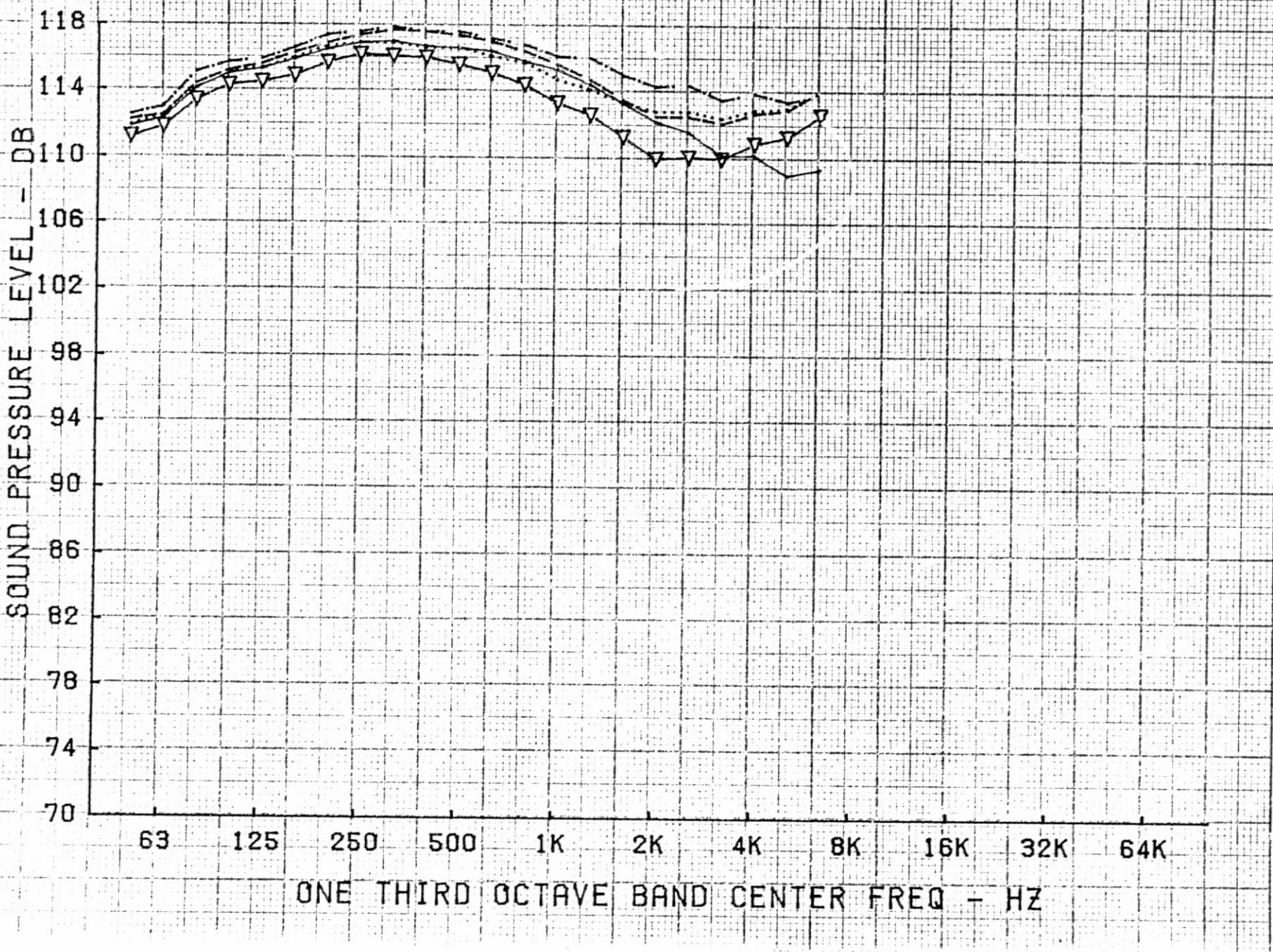
NASA VSCE (NRS3-20061) TE. 1 PT. 13

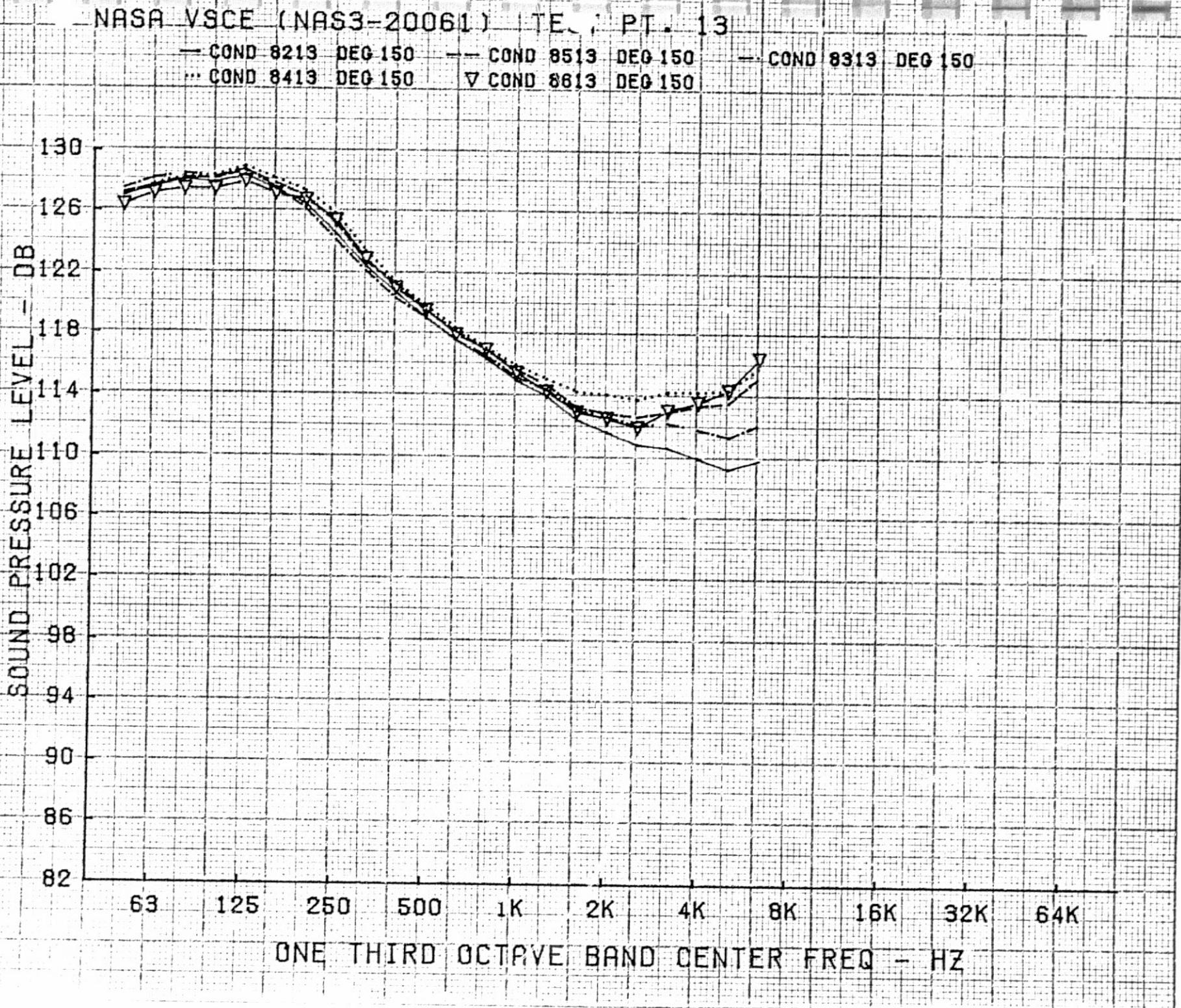
— COND 8213 DEG 90 — COND 8513 DEG 90 - COND 8313 DEG 90
... COND 8413 DEG 90 V COND 8613 DEG 90



NASA VSCE (NAS3-20061) TE. I PT. 13

— COND 8213 DEG 120 - - COND 8513 DEG 120 - COND 8313 DEG 120
... COND 8413 DEG 120 ▽ COND 8613 DEG 120

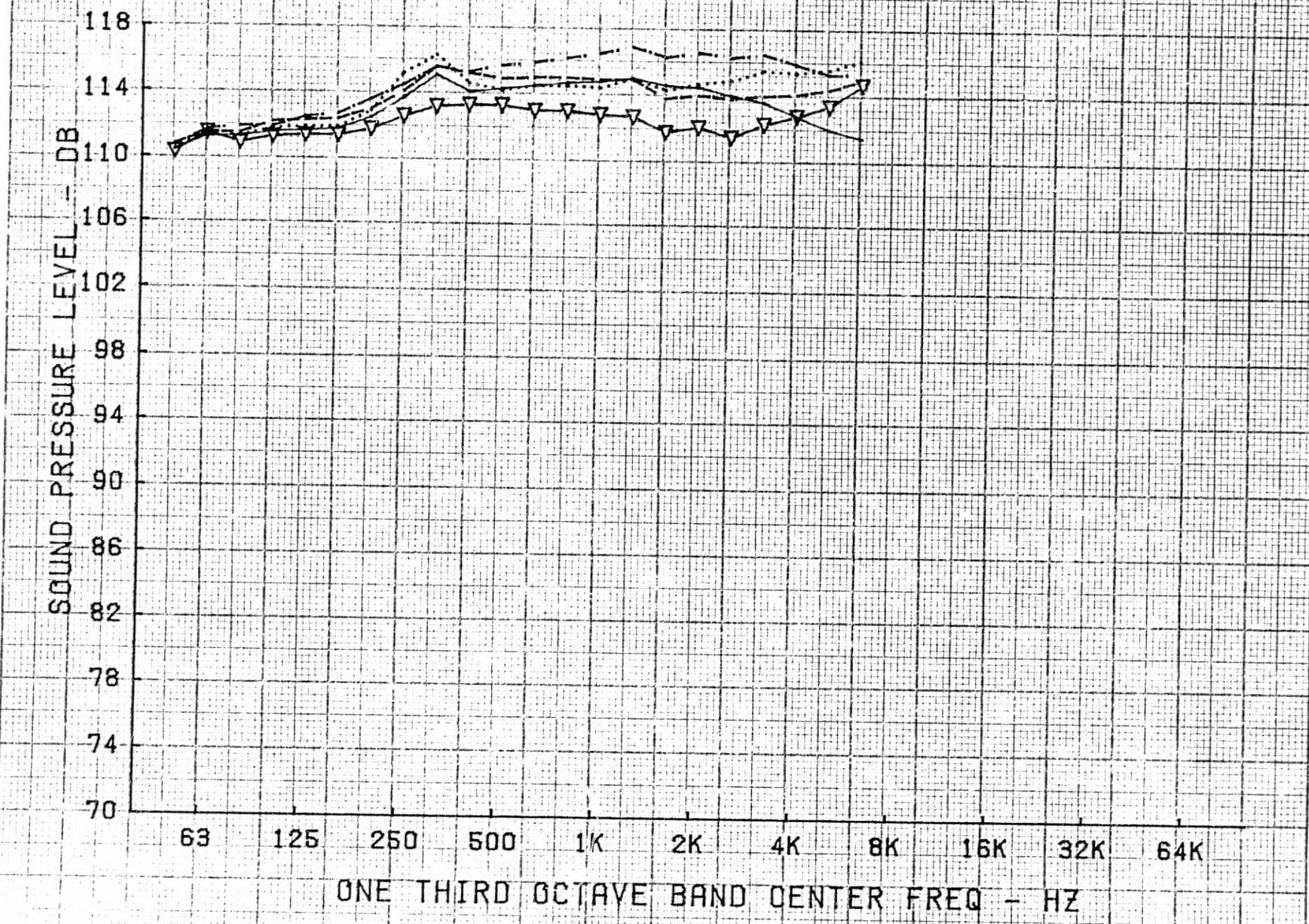




NASA VSCE (NAS3-20061) TE : PT. 14

— COND 8214 DEG 90
... COND 8414 DEG 90-- COND 8514 DEG 90
▽ COND 8614 DEG 90

— COND 8314 DEG 90



NASA VSCE (NAS3-20061) TE 1 PT. 14

— COND 8214 DEG 120
... COND 8414 DEG 120

-- COND 8514 DEG 120
▽ COND 8614 DEG 120

-- COND 8314 DEG 120

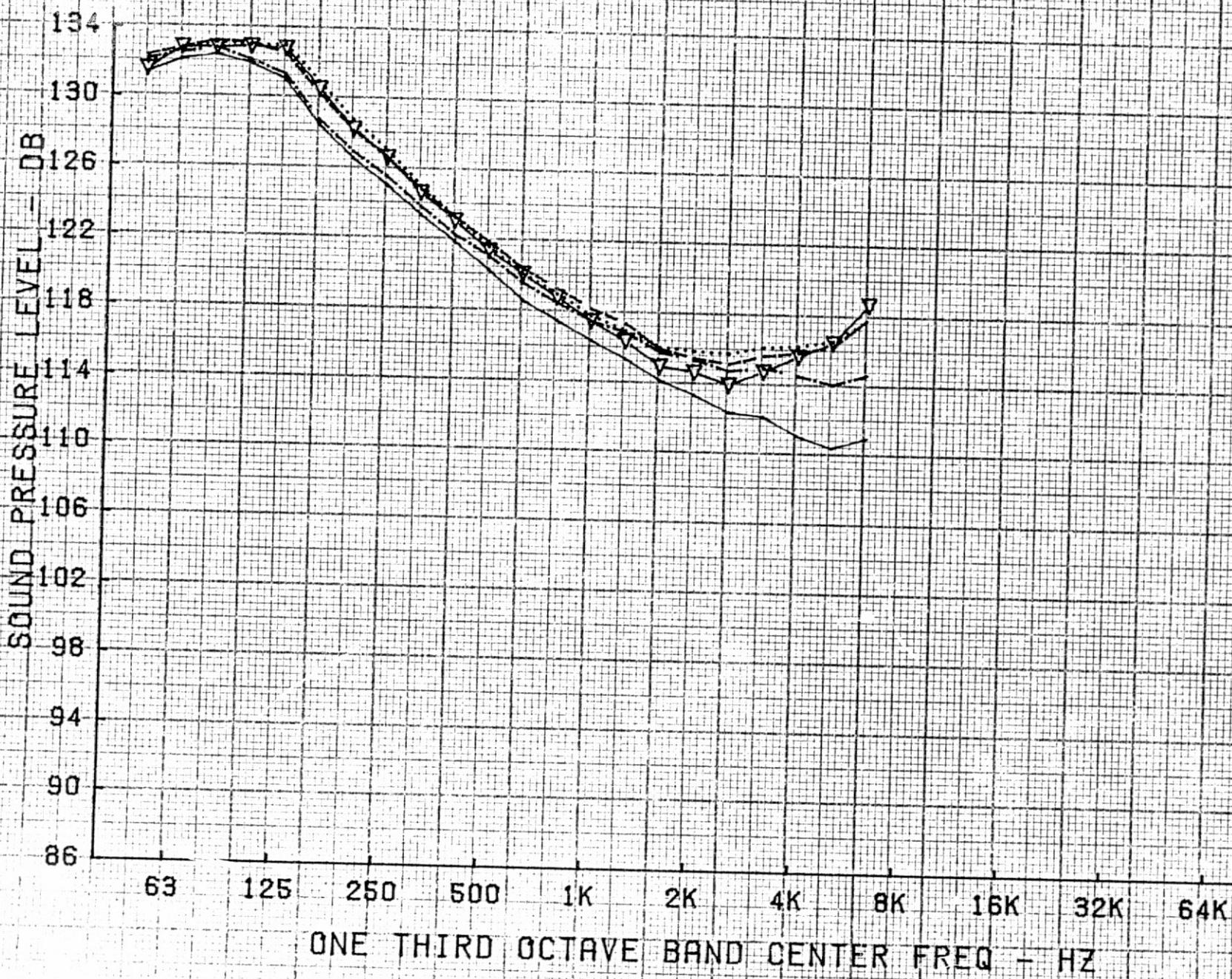


NASA VSCE (NAS3-20061) TE PT. 14

COND 8214 DEG 150
... COND 8414 DEG 150

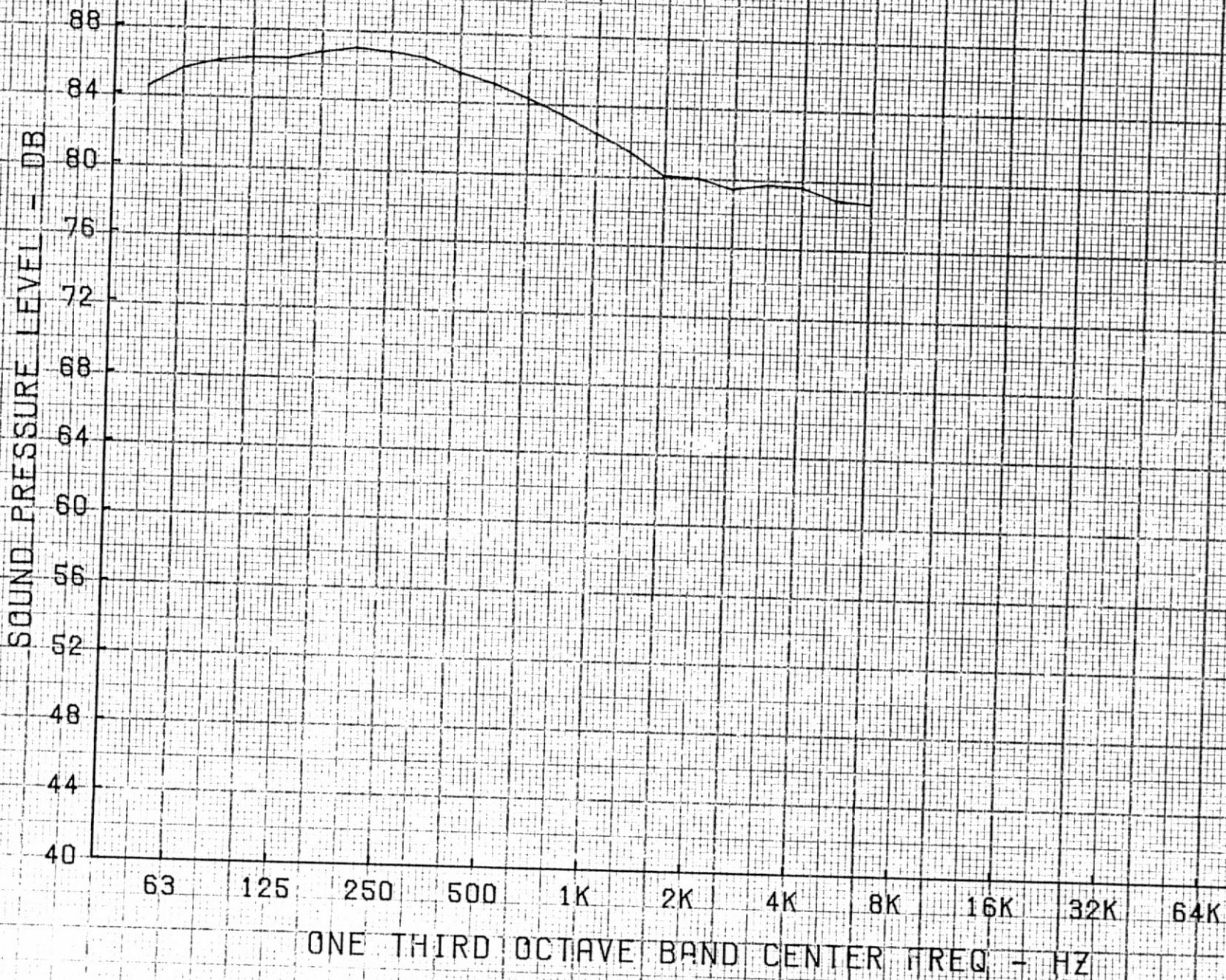
-- COND 8514 DEG 150
▽ COND 8614 DEG 150

- COND 8314 DEG 150



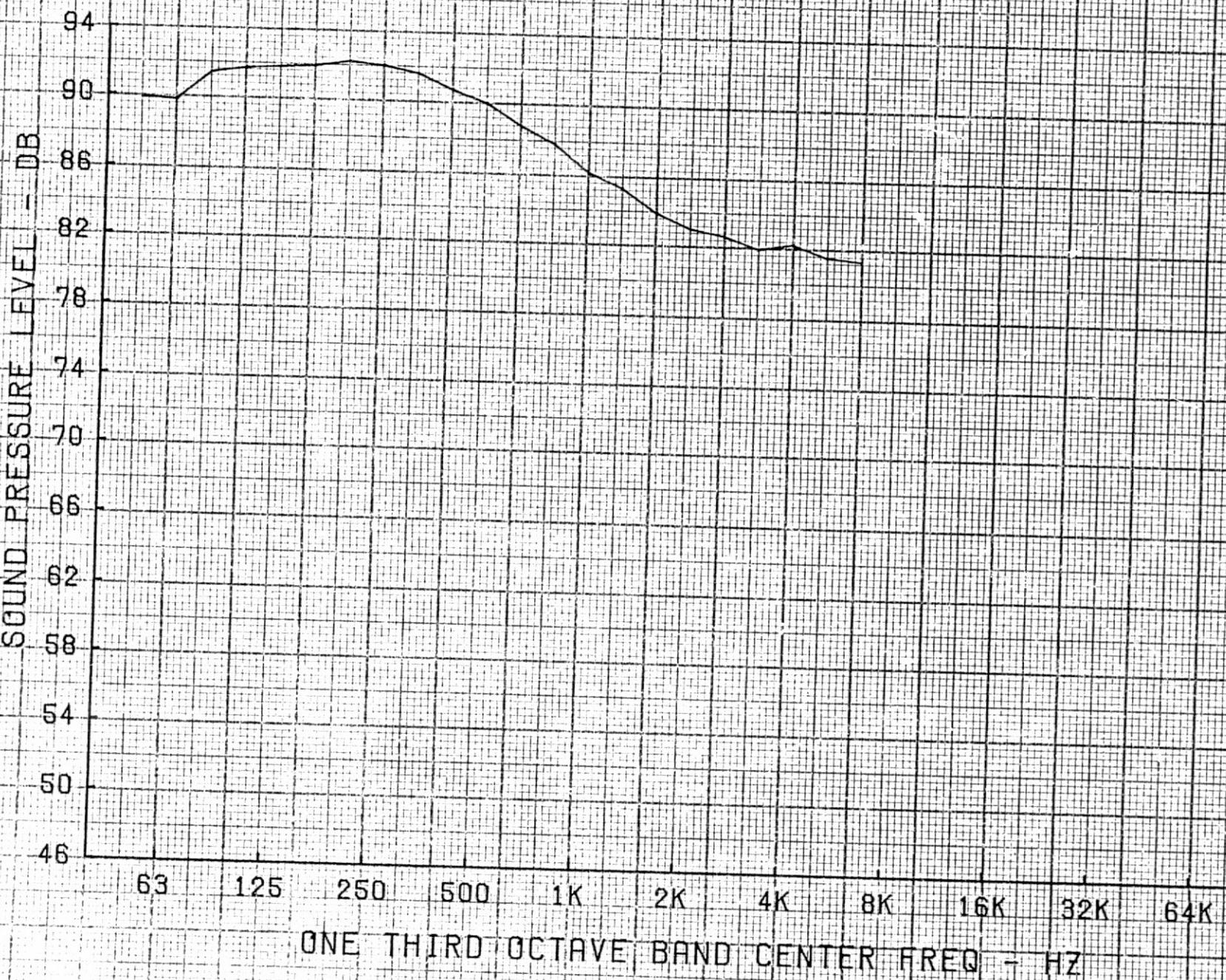
NASA VSCE (NAS3-20061) TE PT. 15
COND 8216 DEG 90

B-43



NASA VSCE (NAS3-20061)ITE PT. 15

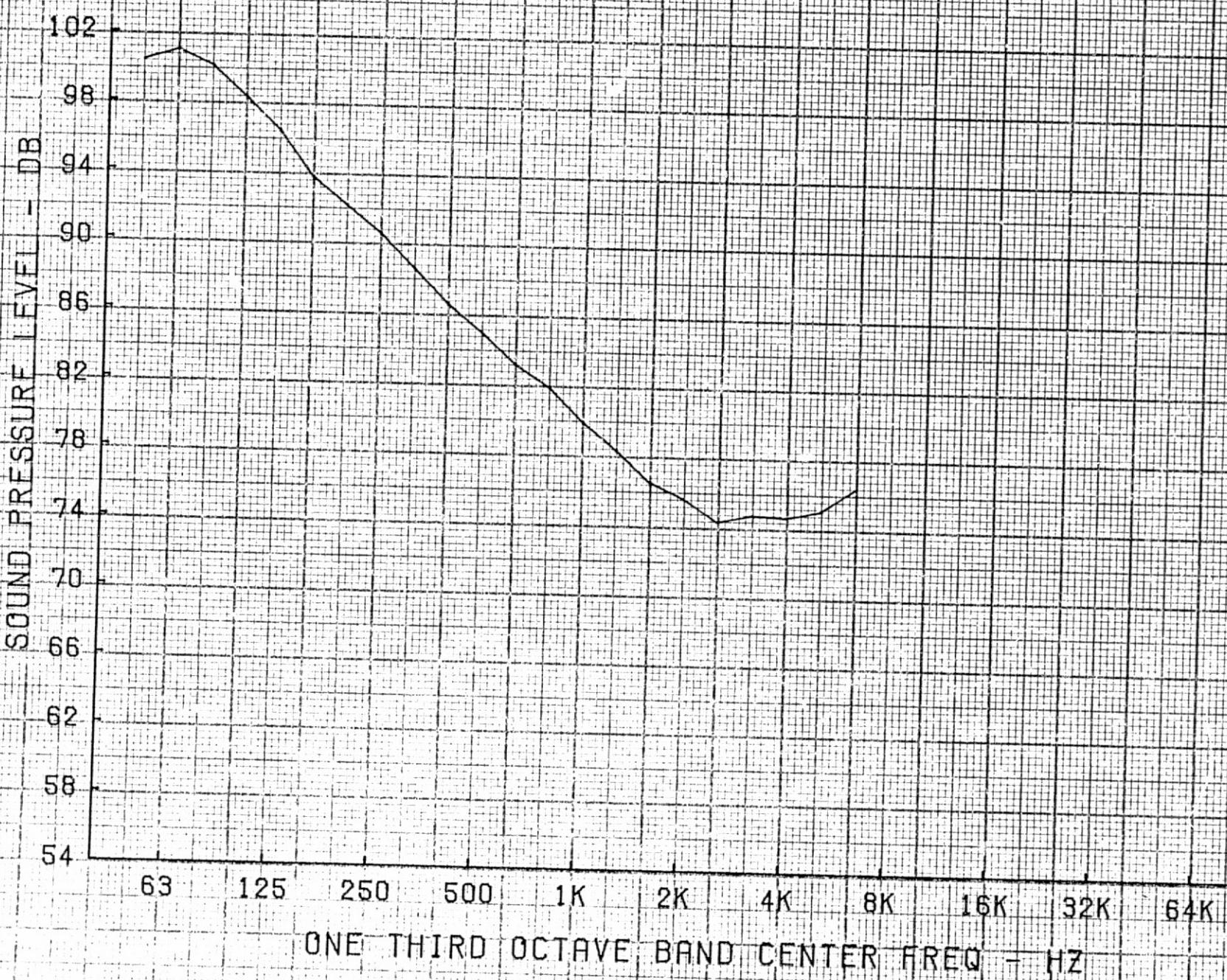
COND 8215 DEG 120



NASA VSGE (NAS3-20061)ITE PT. 15

COND 8215 DEG 160

B-45



NASA VSCE (NAS3-20061) TEC PT. 16

— COND 8116 DEG 90

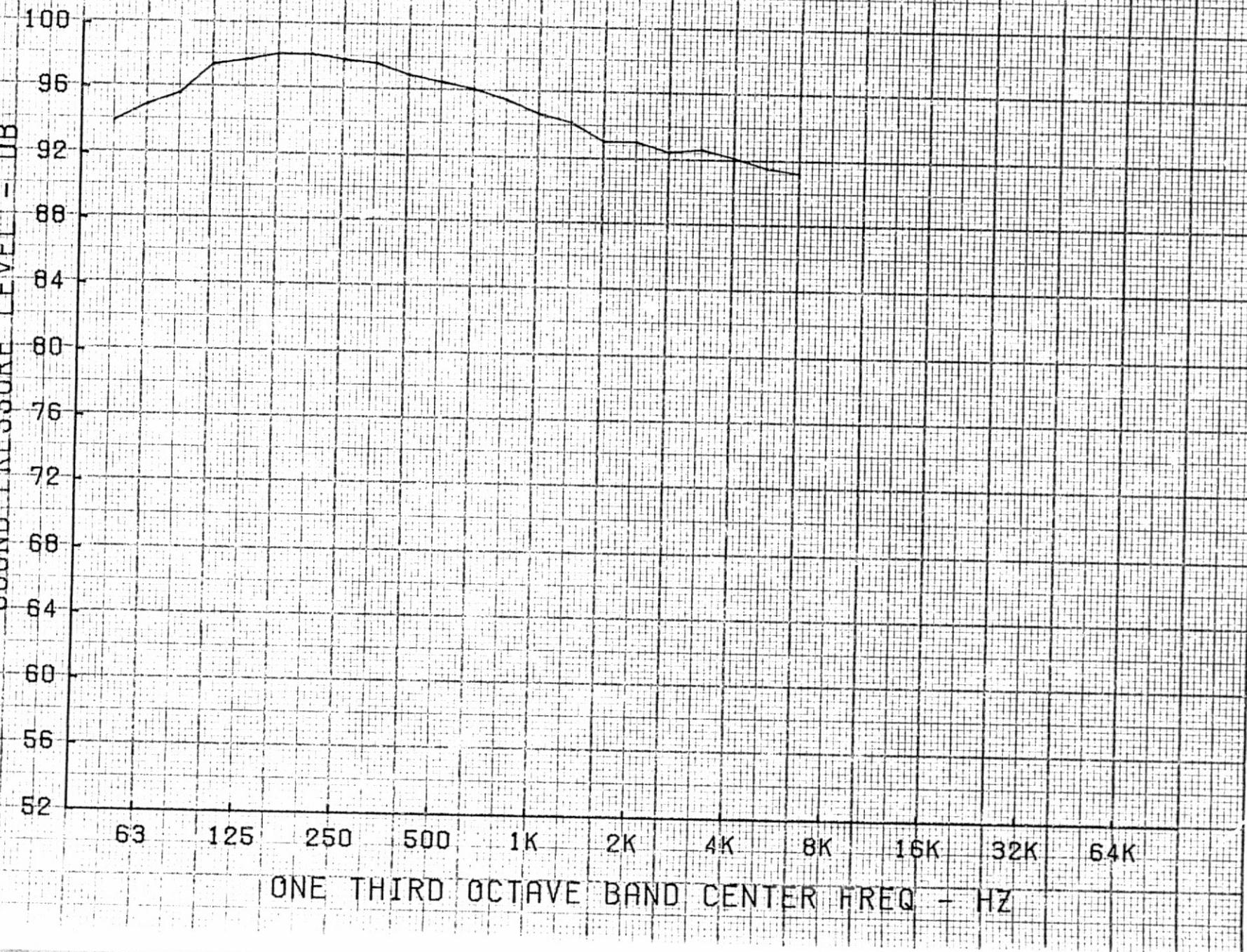
B46

SOUND PRESSURE LEVEL - DB

100
96
92
88
84
80
76
72
68
64
60
56
52

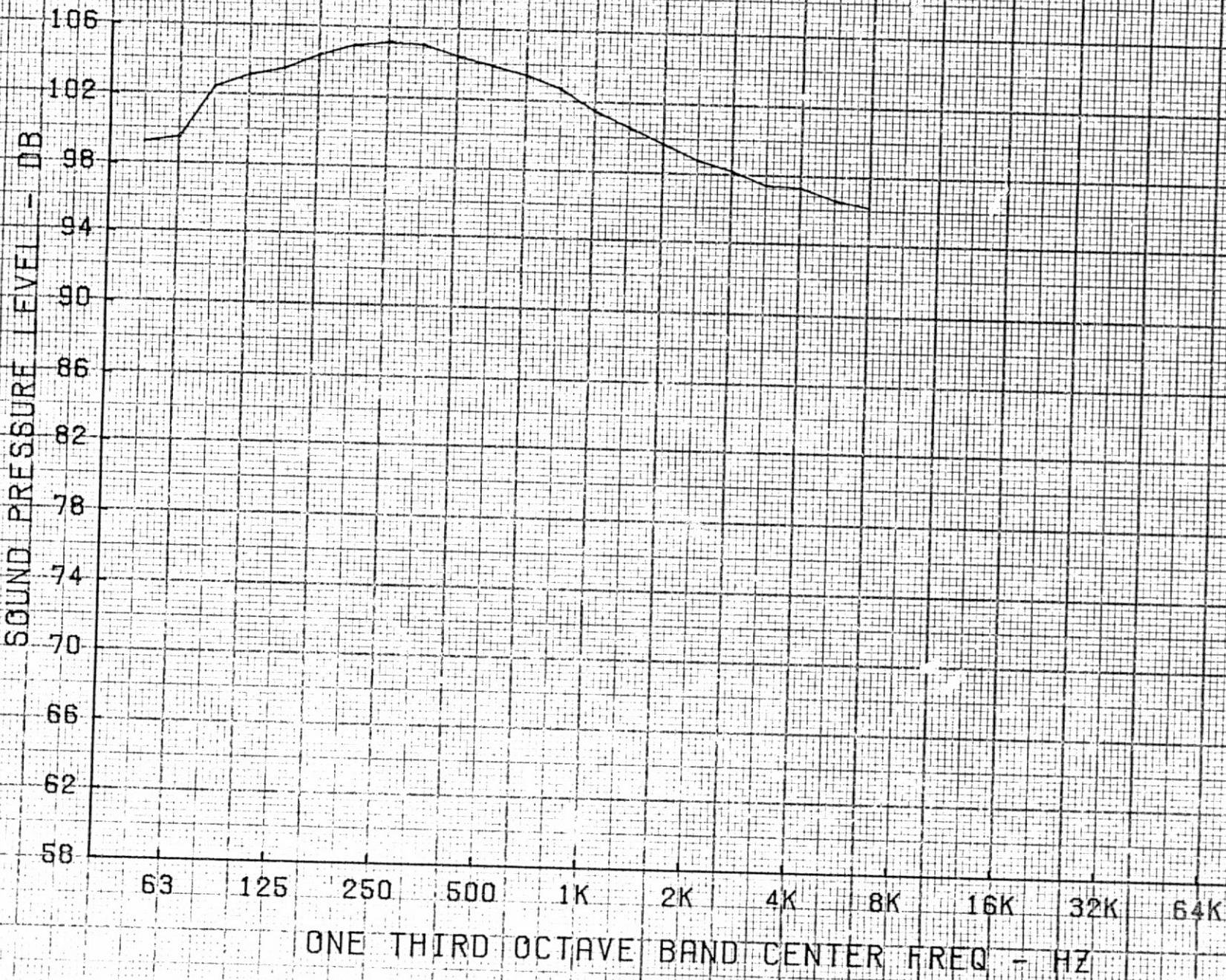
63 125 250 500 1K 2K 4K 8K 16K 32K 64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz



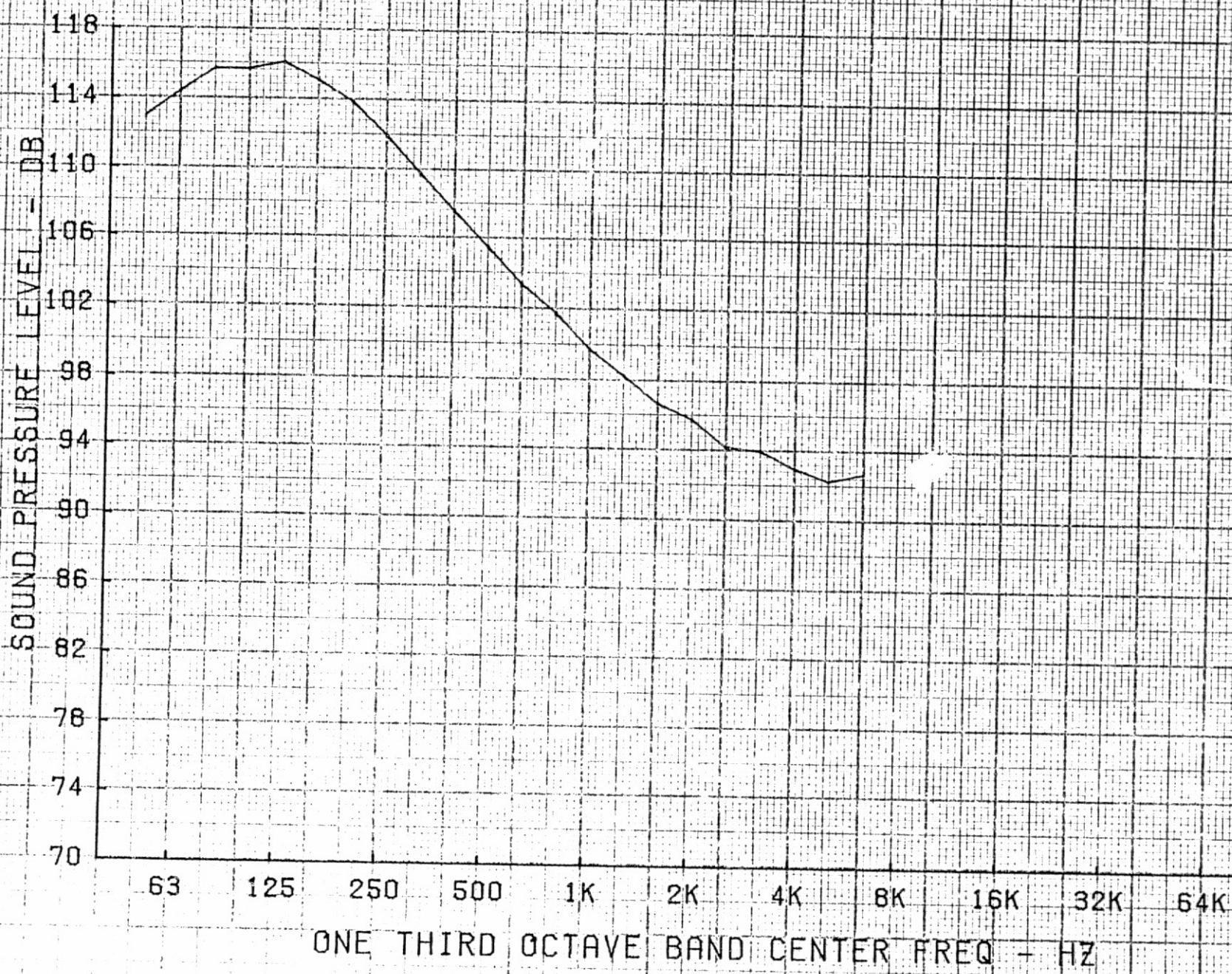
NASA VSCE (NAS3-20061) TE, PT. 16

— COND 8116 DEG 120

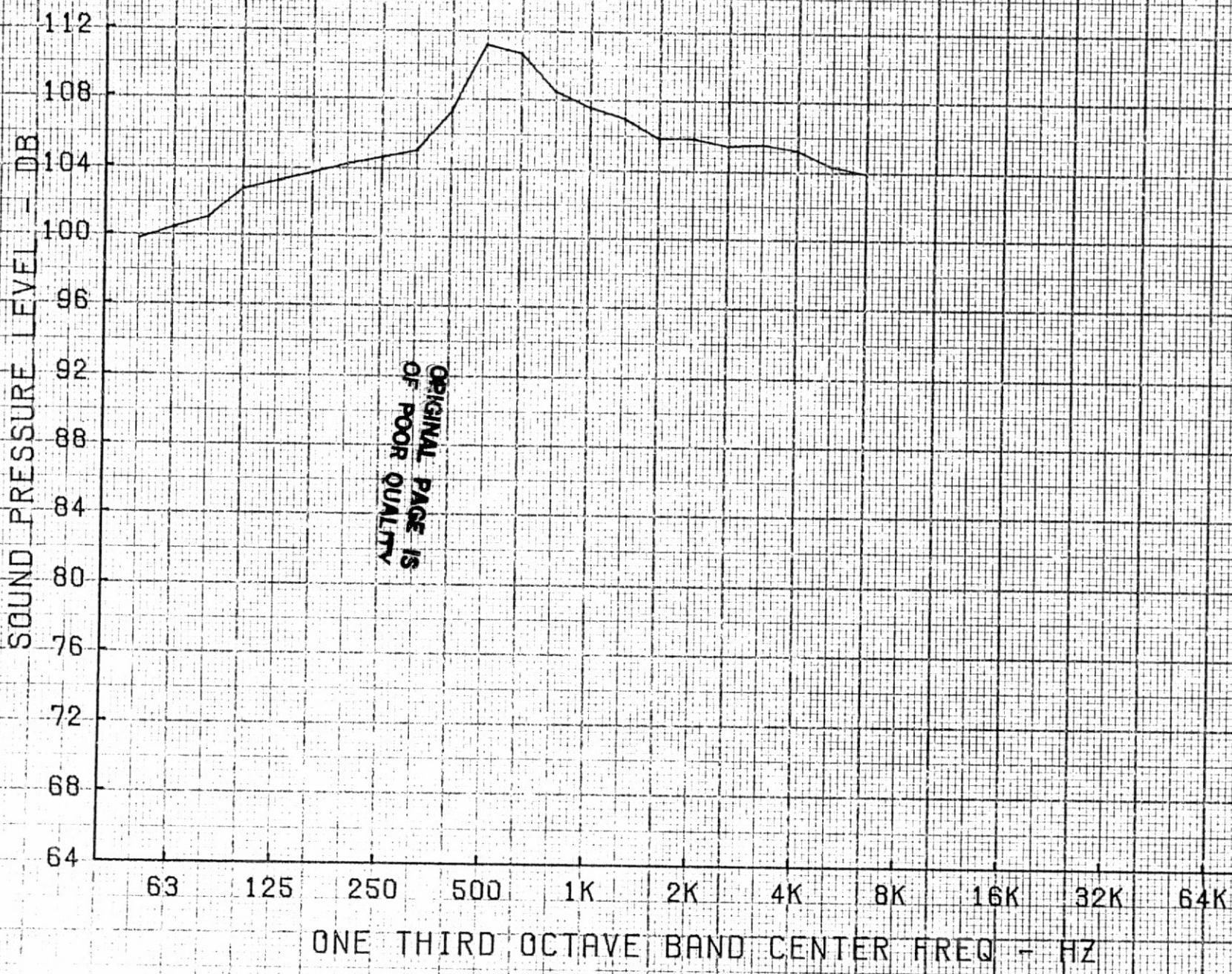


NASA VSCE (NAS3-20061) TEL PT. 16
COND 6116 DEG 150

B-48



NASA VSCE (NAS3-20061) TE PT. 17
— COND 8217 DEG 90



NASA VSCE (NAS3-20061) TE PT. 17

COND 8217 DEG 120

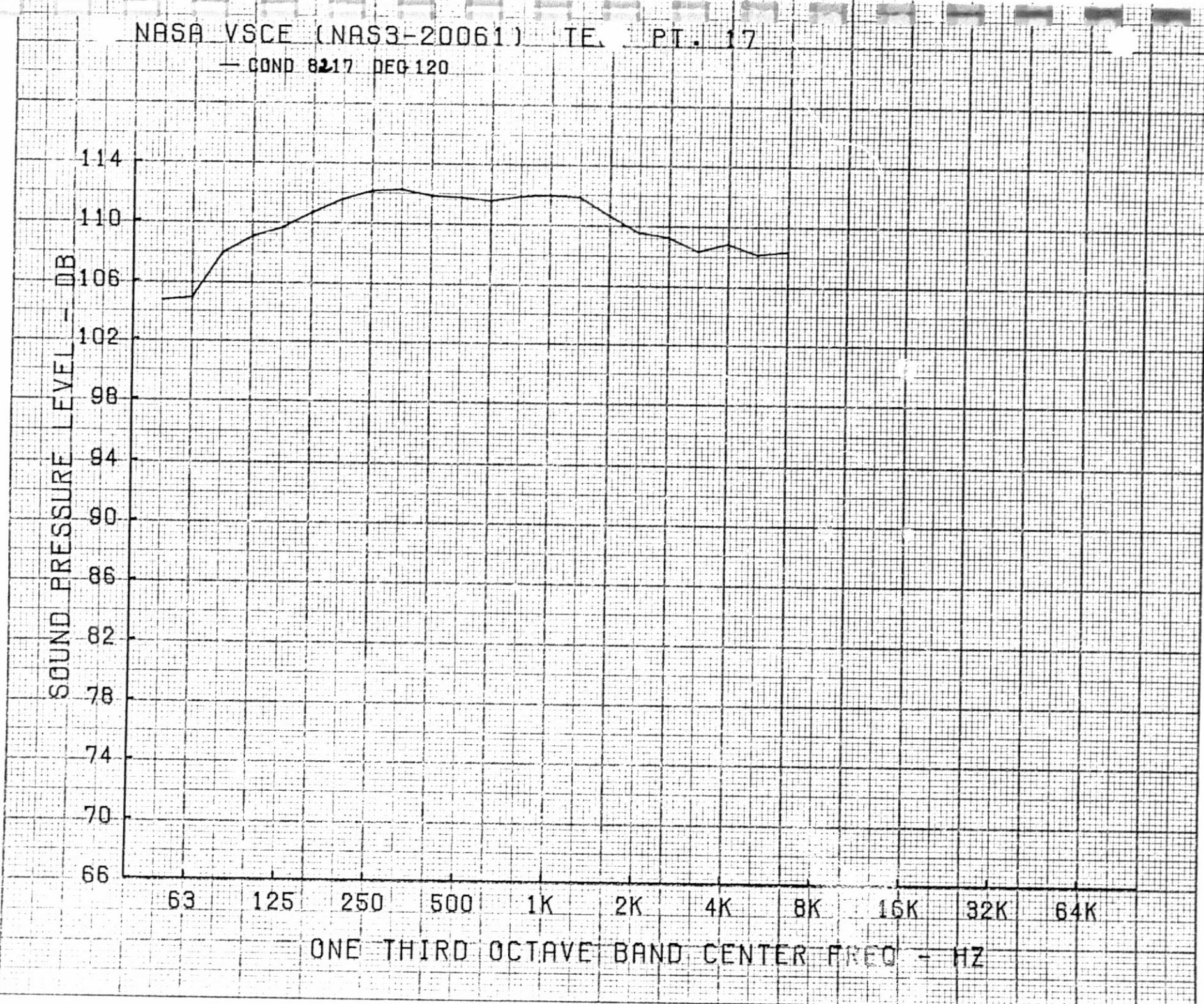
05-B

114
110
106
102
98
94
90
86
82
78
74
70
66

SOUND PRESSURE LEVEL - DB

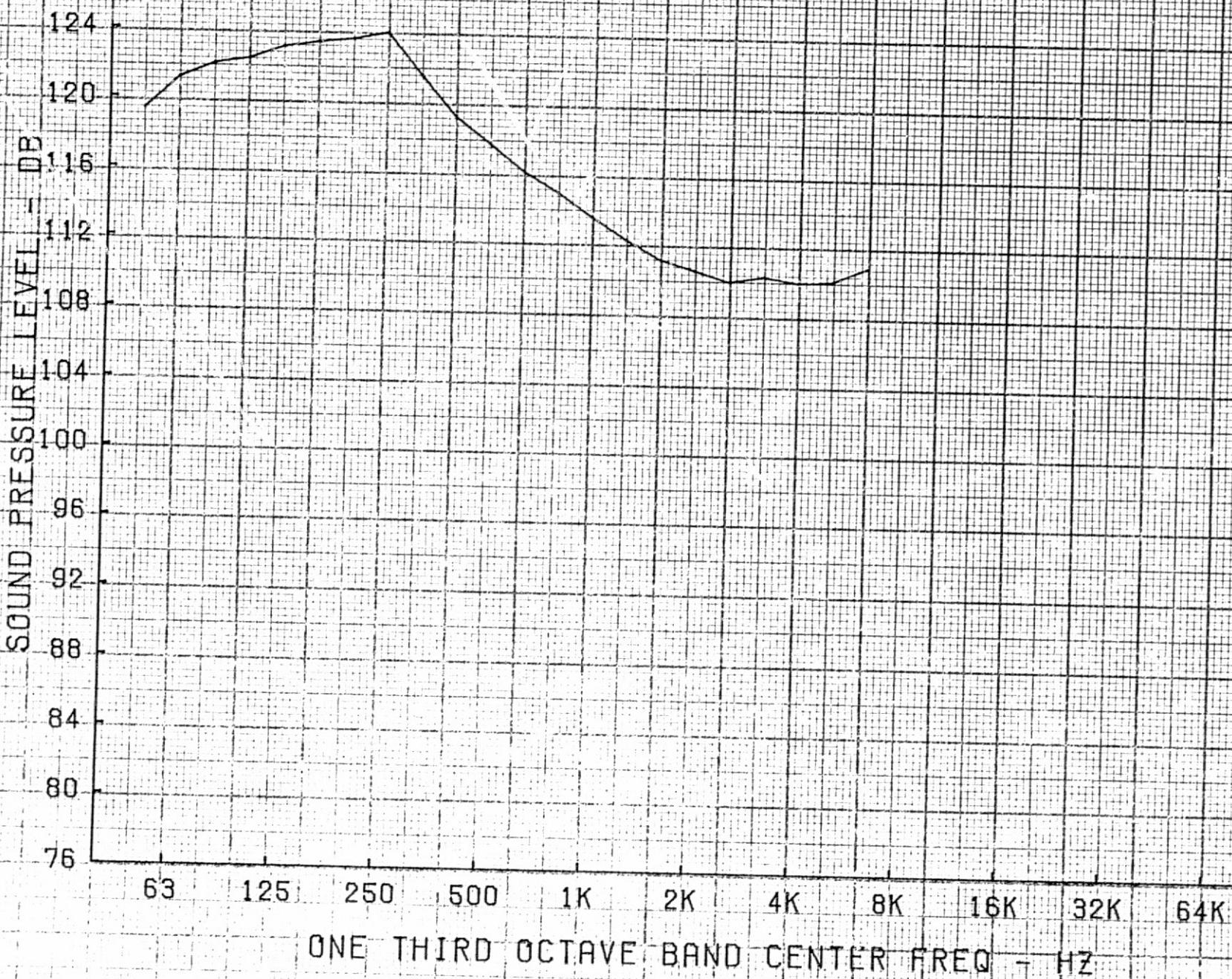
63 125 250 500 1K 2K 4K 8K 16K 32K 64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz



NASA VSCE (NAS3-20061) TE PT. 17
COND 8217 DEG 150

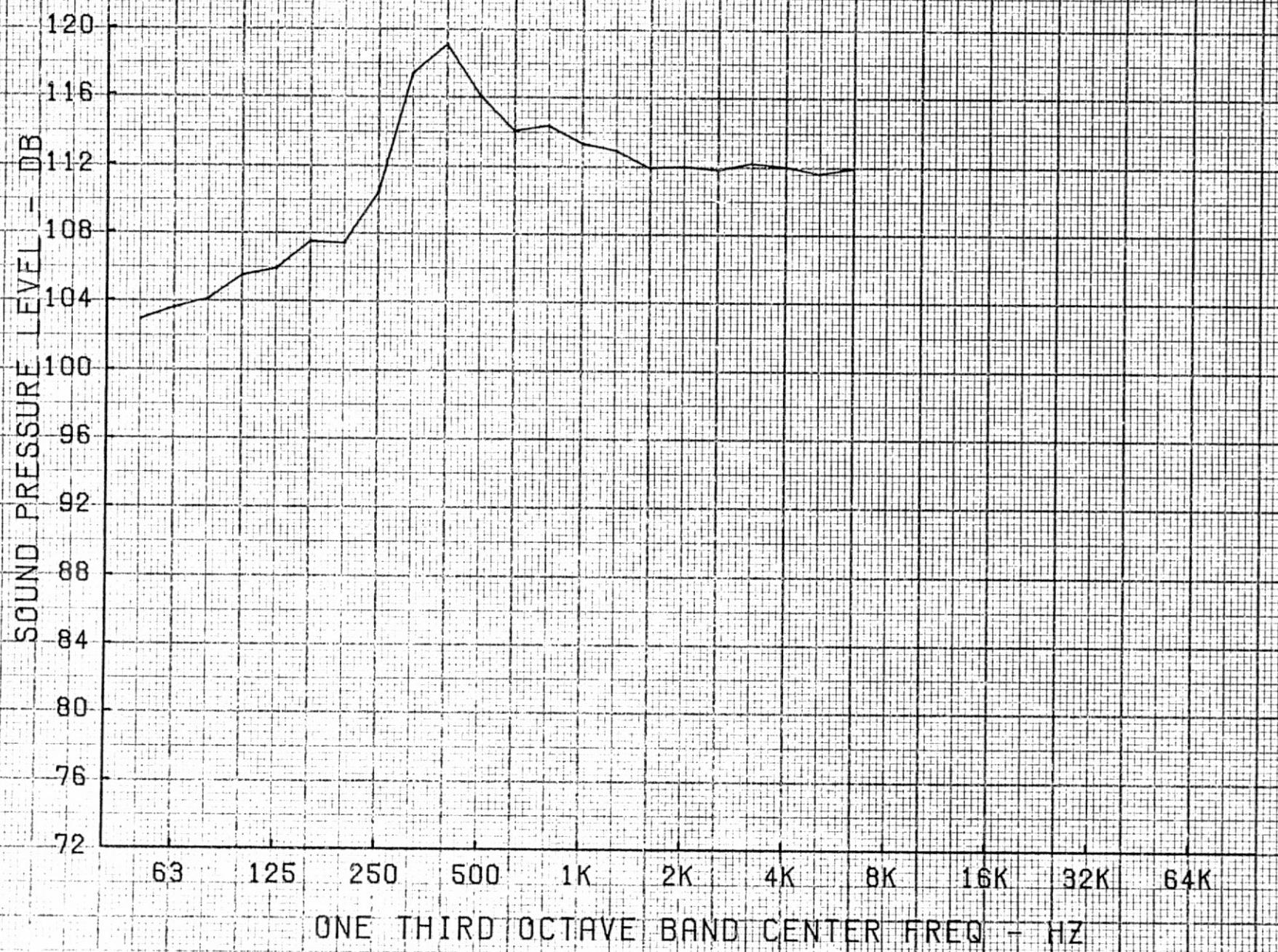
15-B



NASA VSCE (NAS3-20061) TE PT. 18

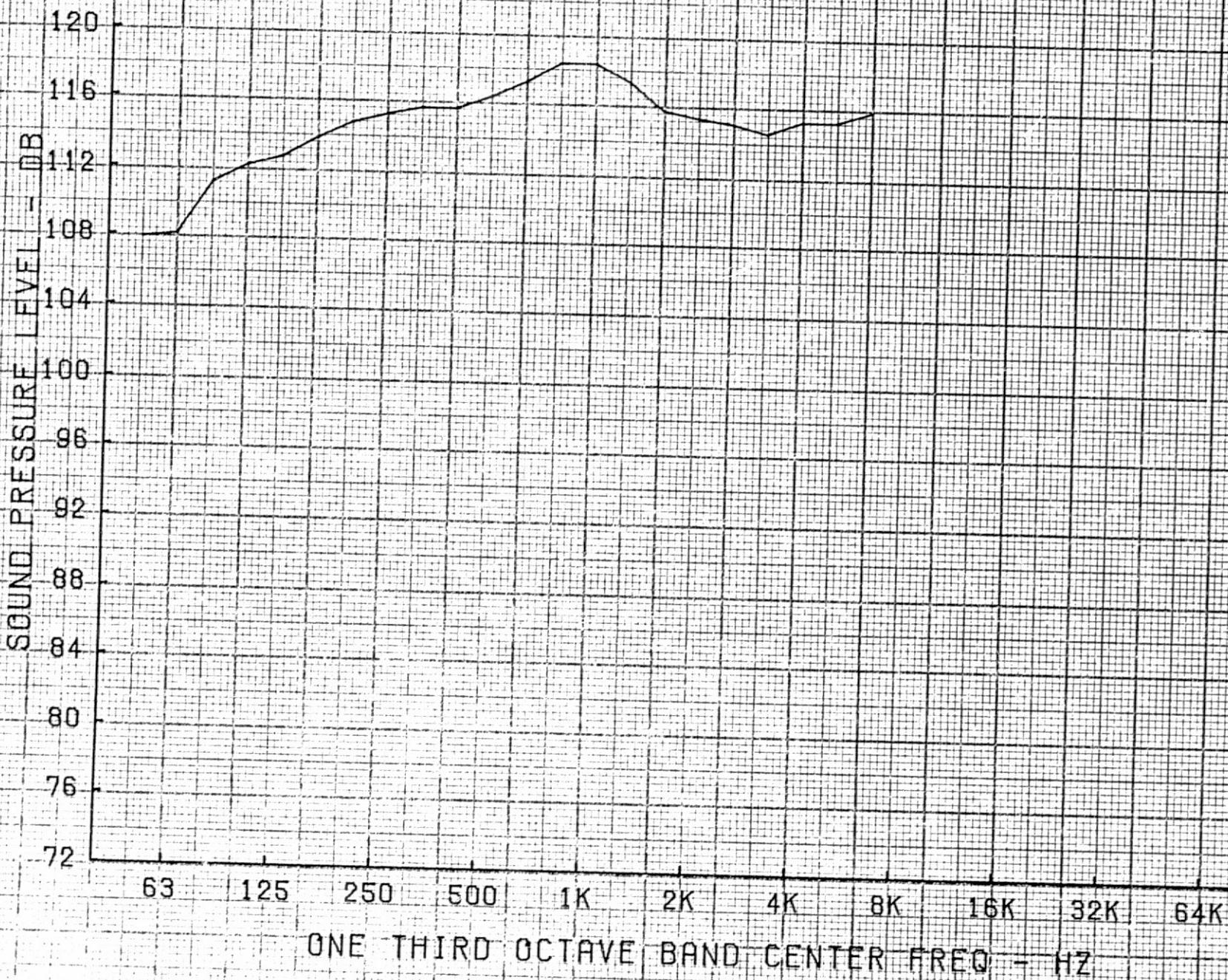
COND 8218 DEG 90

B-52



NASA VSCE (NAS3-20061) TE : PT. 18

COND 8218 DEG 120



NASA VSCE (NAS3-20061) TE PT. 18

COND 8218 DEG 150

B-54



NASA VSCE (NAS3-20061) ITE PT. 19

— COND 8219 DEG 90 - - COND 8519 DEG 90

B-55

SOUND PRESSURE LEVEL - dB

90
86
82
78
74
70
66
62
58
54
50
46
42

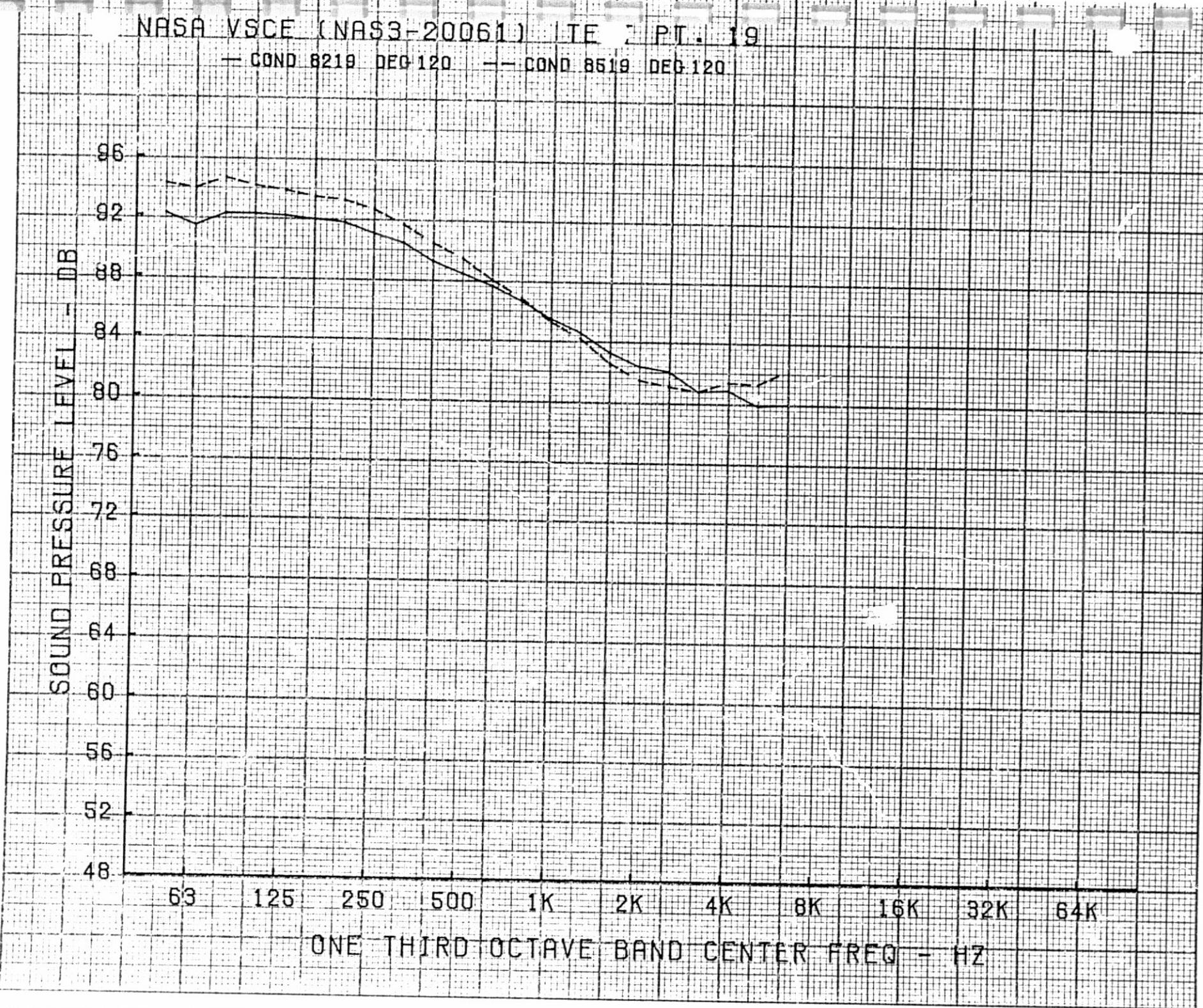
63 125 250 500 1K 2K 4K 8K 16K 32K 64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz

NASA VSCE (NAS3-20061) ITE P.T. 19

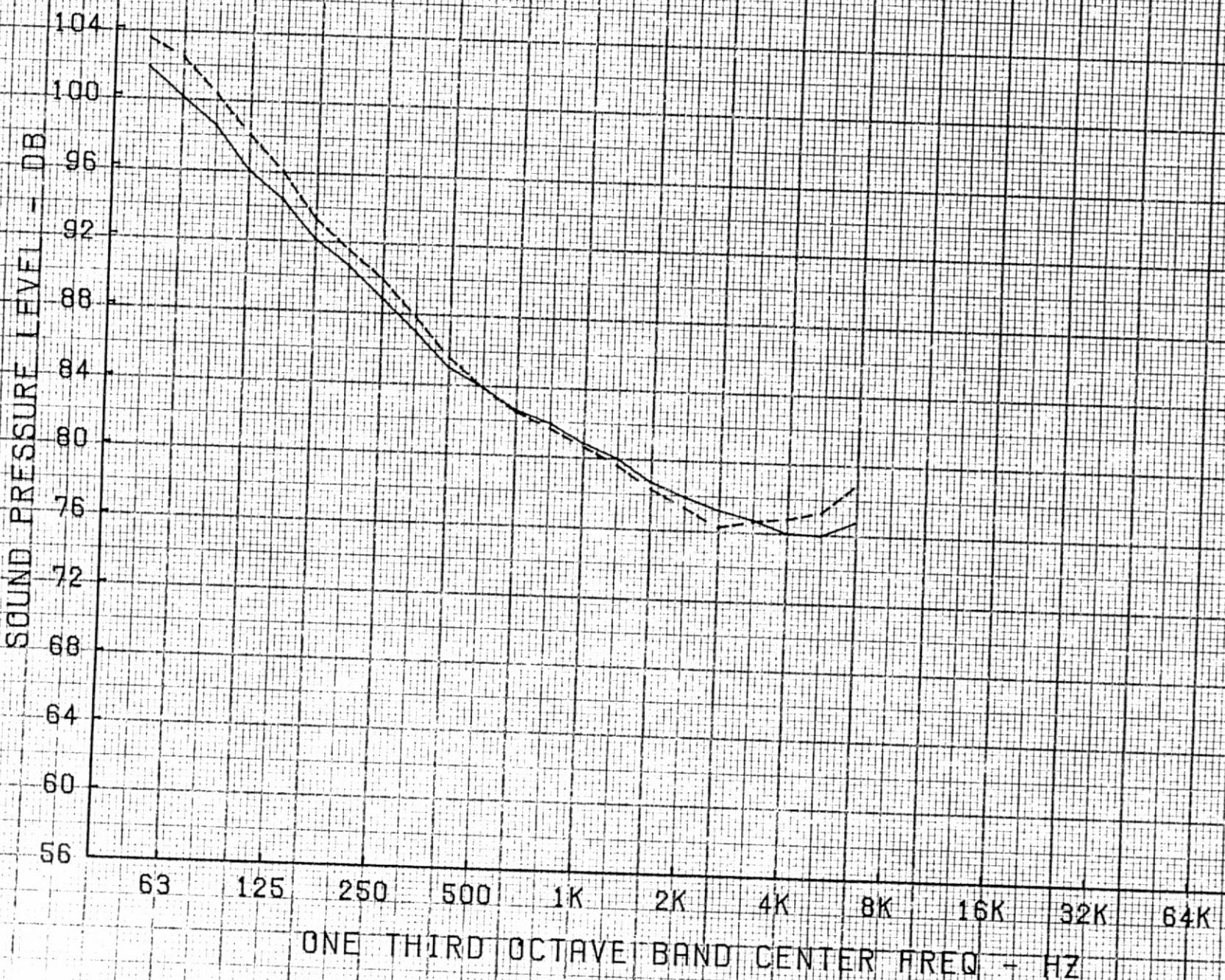
— COND 8219 DEG 120 - - COND 8619 DEG 120

B-56



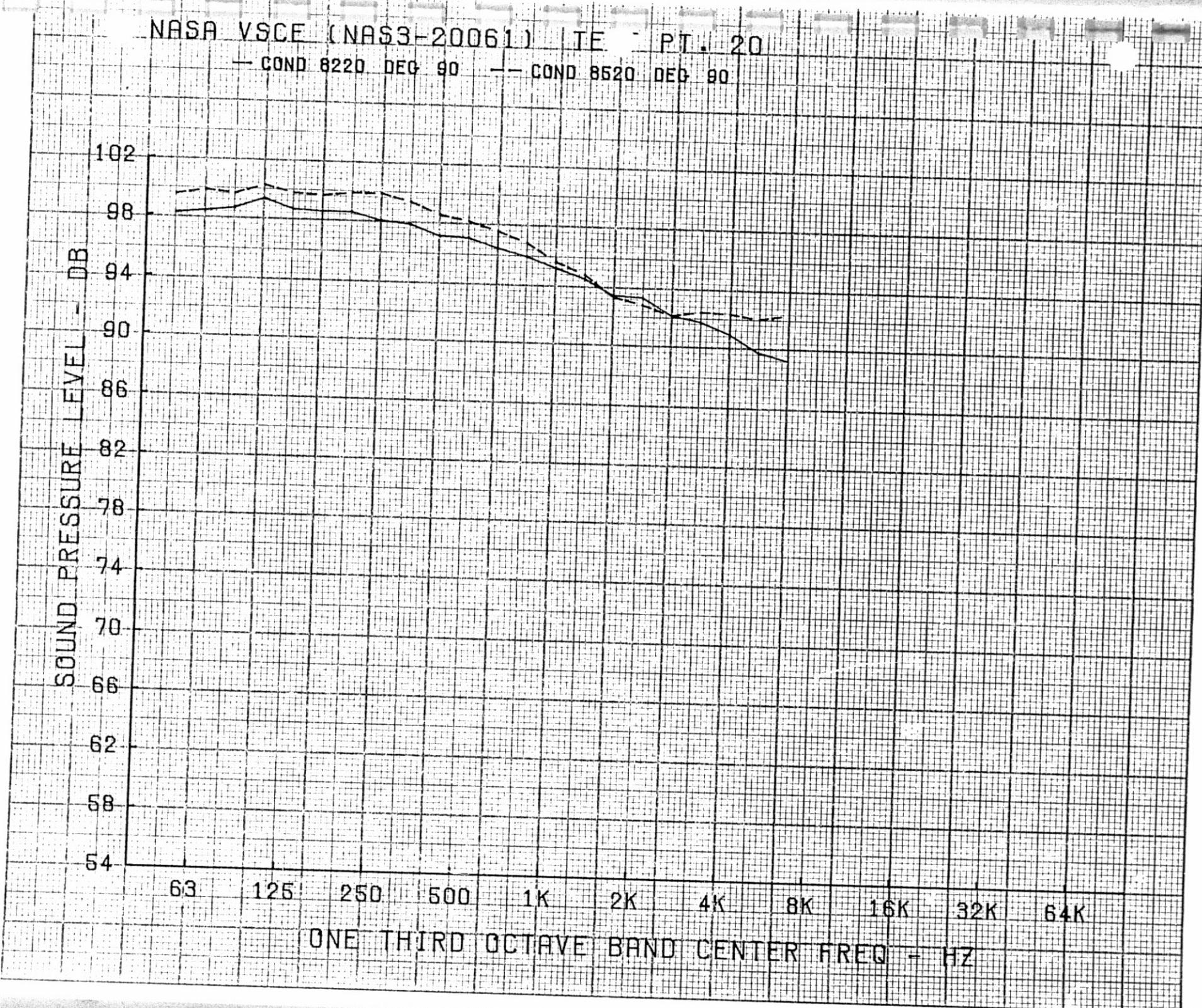
NASA VSCE (NAS3-20061) TE, PT. 19

— COND 8219 DEG 150 - - COND 8519 DEG 150



NASA VSCE (NAS3-20061) TE PT. 20
COND 8220 DEG 90 — COND 8520 DEG 90

B58



NASA VSCE (NAS3-20061)ITE . PT. 20

— COND 8220 DEG 120 - - COND 8520 DEG 120



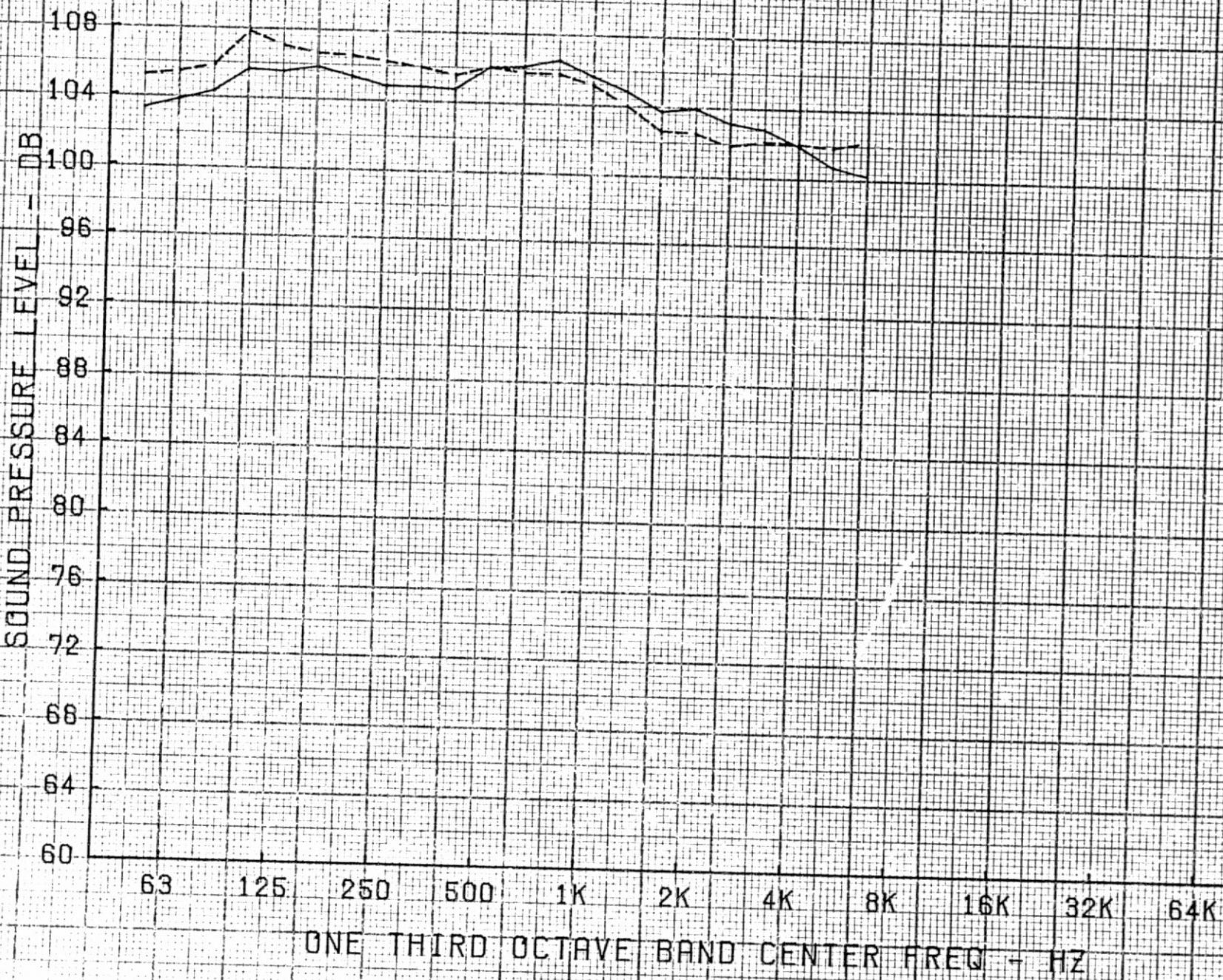
NASA VSCE (NAS3-20061) TE, PT. 20

— COND 8220 DEG 150 - - COND 8520 DEG 150



NASA VSCE (NAS3-20061) TE. PT. 21

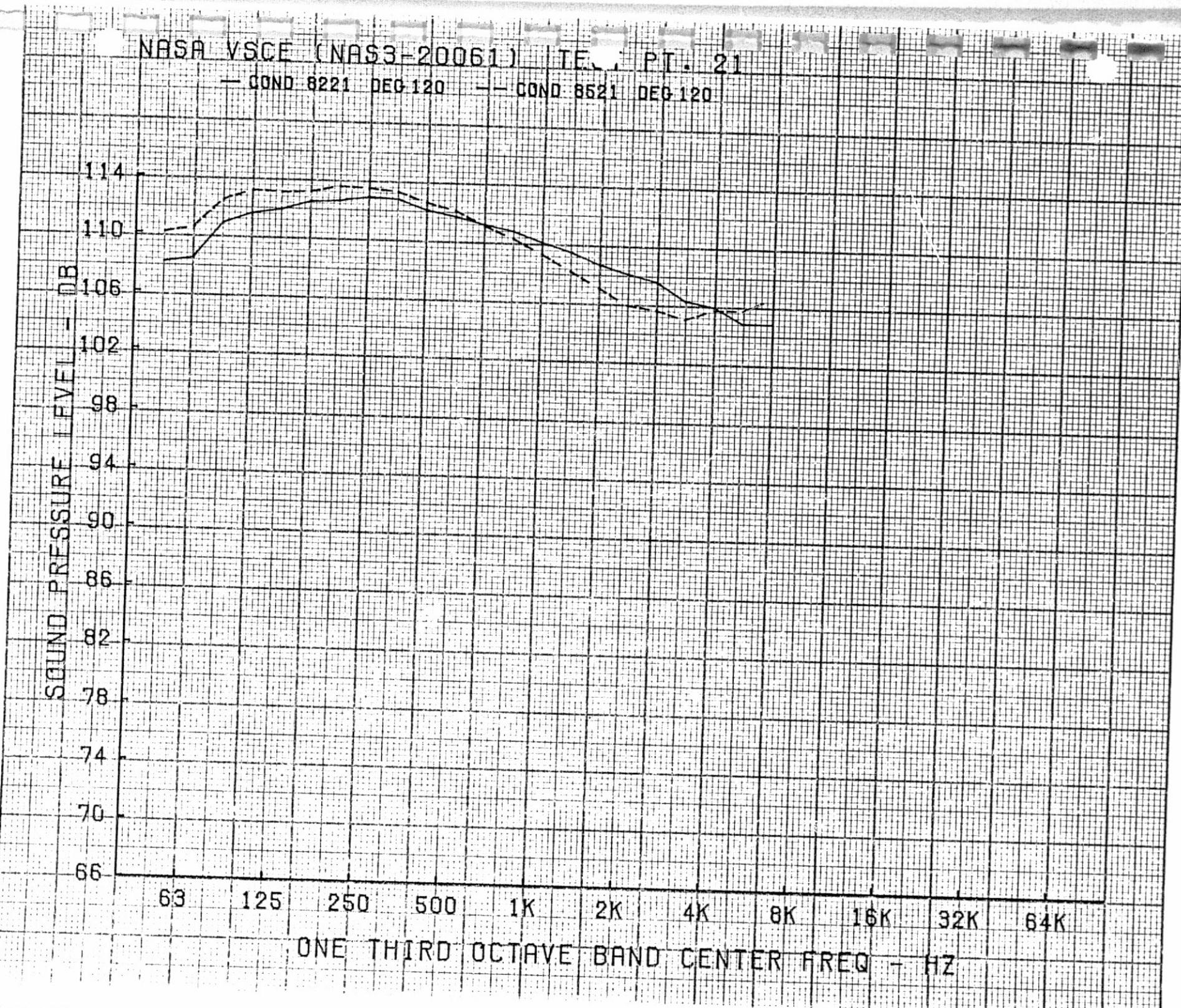
— COND 8221 DEG 90 — COND 8621 DEG 90



NASA VSGE (NAS3-20061) TEC PT. 21

COND 8221 DEG 120 — COND 8521 DEG 120

B-62



NASA VSCE (NAS3-20061) TE PT. 21

— COND 8221 DEG 150 - COND 6521 DEG 150

SOUND PRESSURE LEVEL - DB

128

124

120

116

112

108

104

100

96

92

88

84

80

63

125

250

500

1K

2K

4K

8K

16K

32K

64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz

NASA VSCE (NAS3-20061) TE, PT, 22

— COND 8222 DEG 90 - - COND 8522 DEG 90

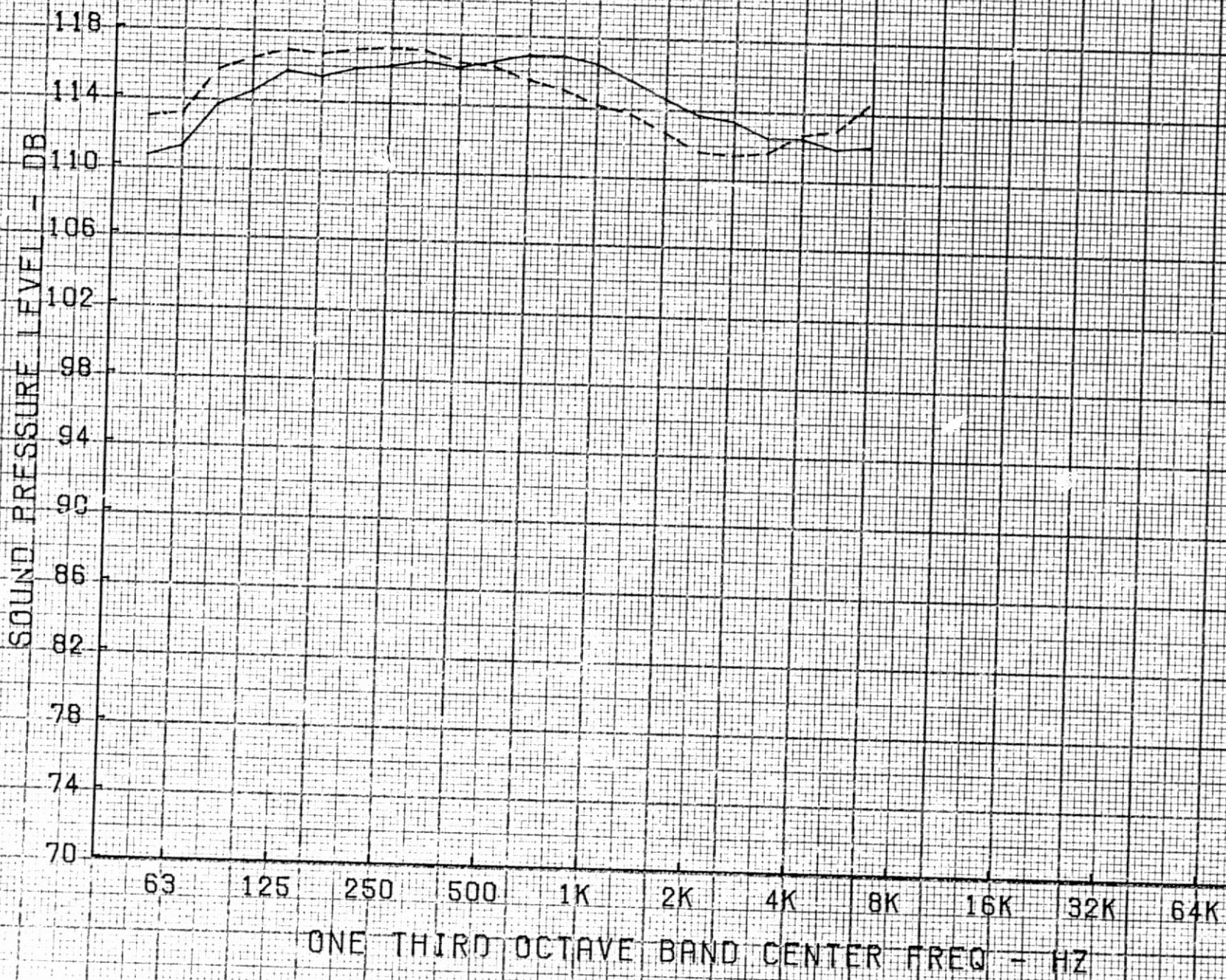


ONE THIRD OCTAVE BAND CENTER FREQ = Hz

NASA VSCE (NAS3-20061) TE : PT. 22

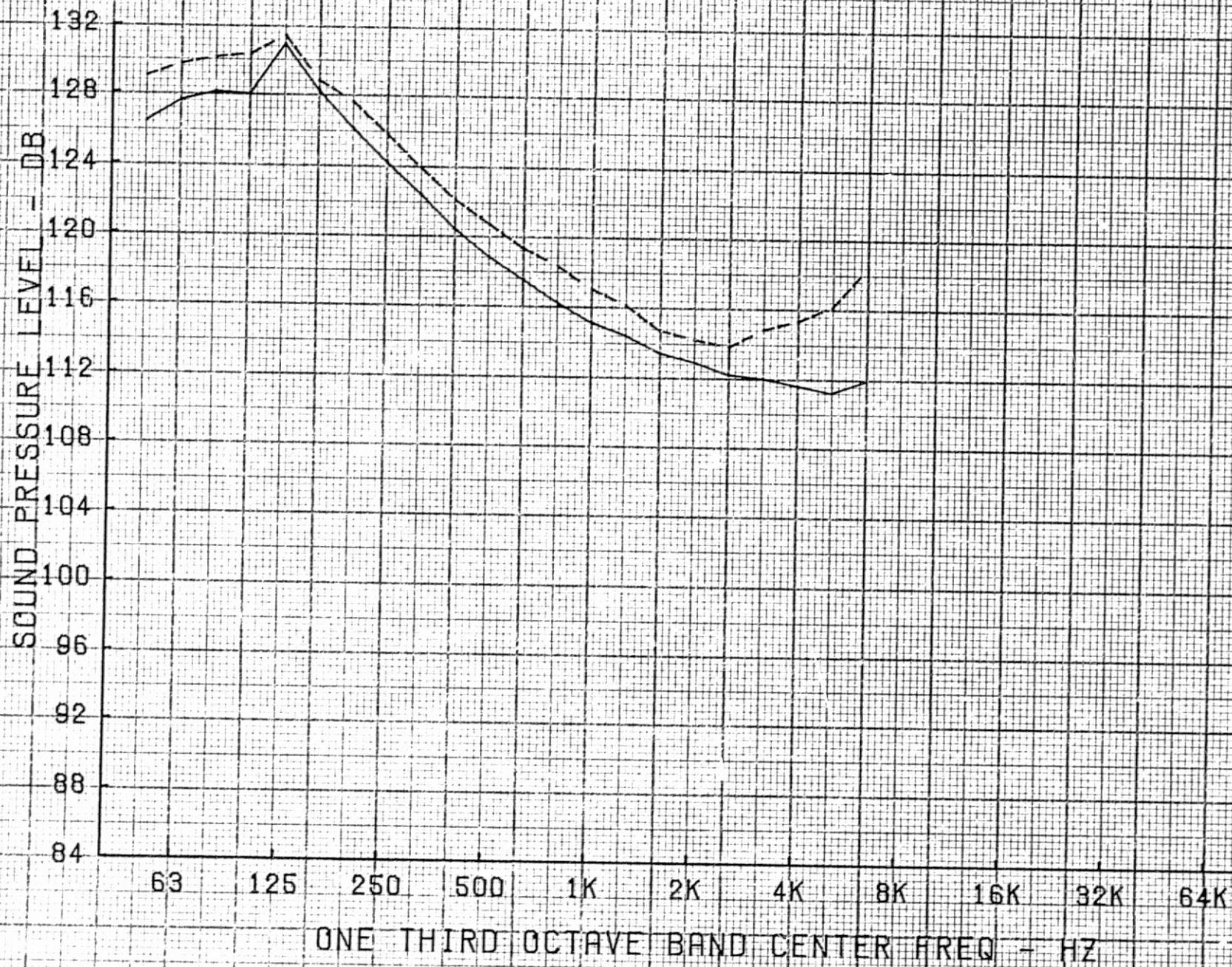
— COND 8222 DEG 120 — COND 8522 DEG 120

B-65



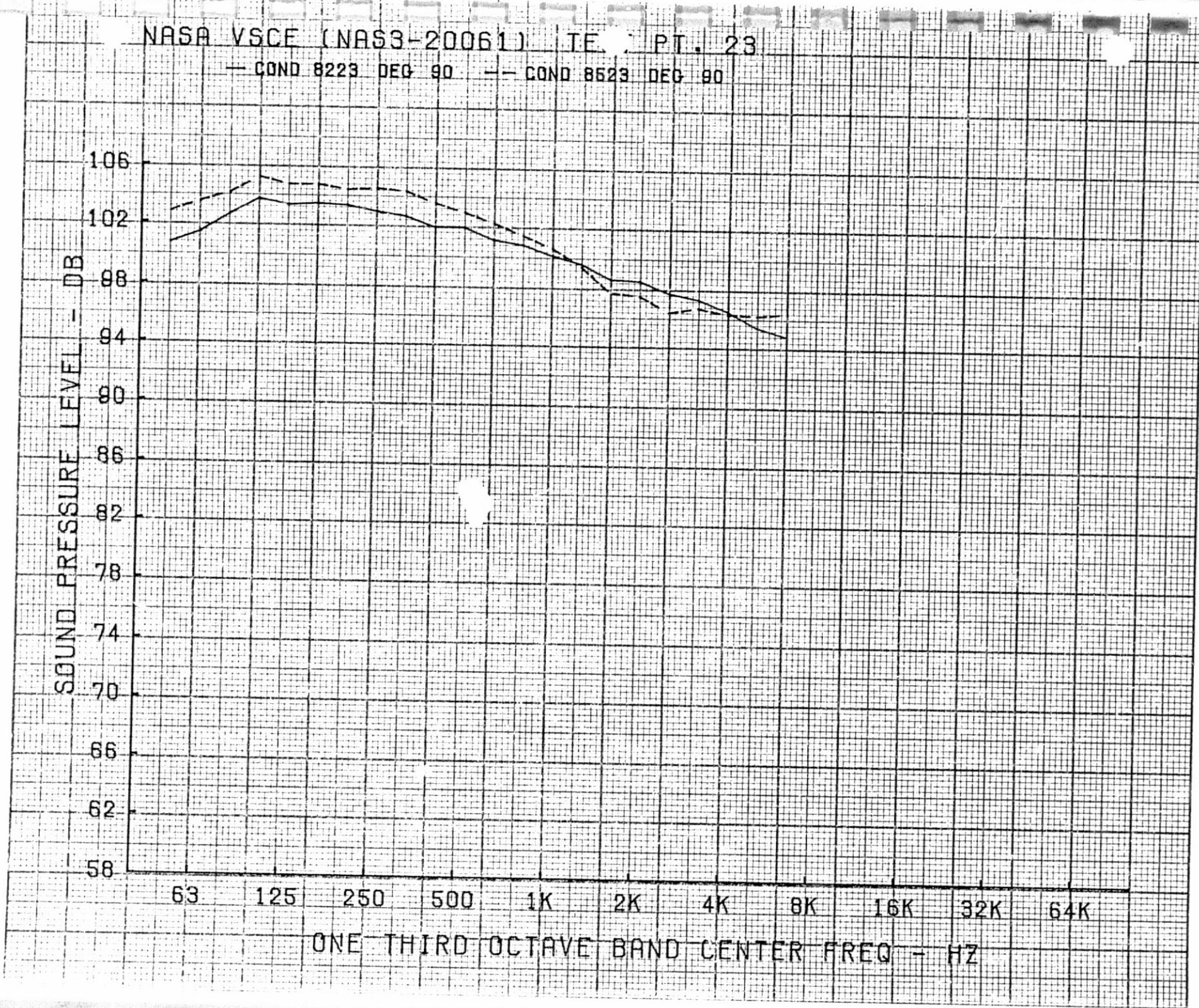
NASA VSCE (NAS3-20061) TE PPT. 22

— COND 8222 DEG 150 — COND 8522 DEG 150



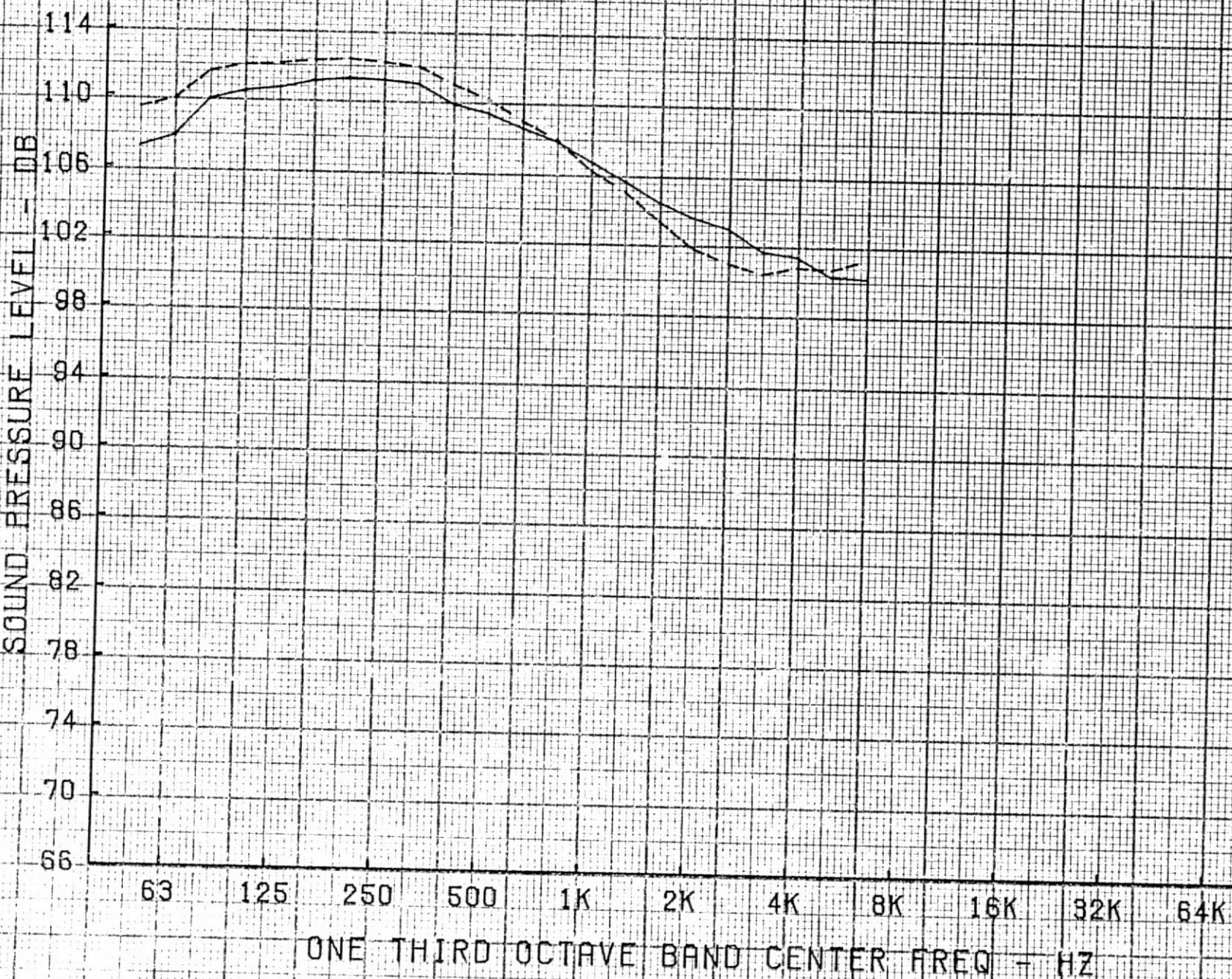
NASA VSCF (NAS3-20061) TE PT. 23
— COND 8223 DEG 90 — COND 8623 DEG 90

B-67



NASA VSCE (NAS3-20061) TE PT. 23

— COND 8223 DEG 120 - - COND 8523 DEG 120



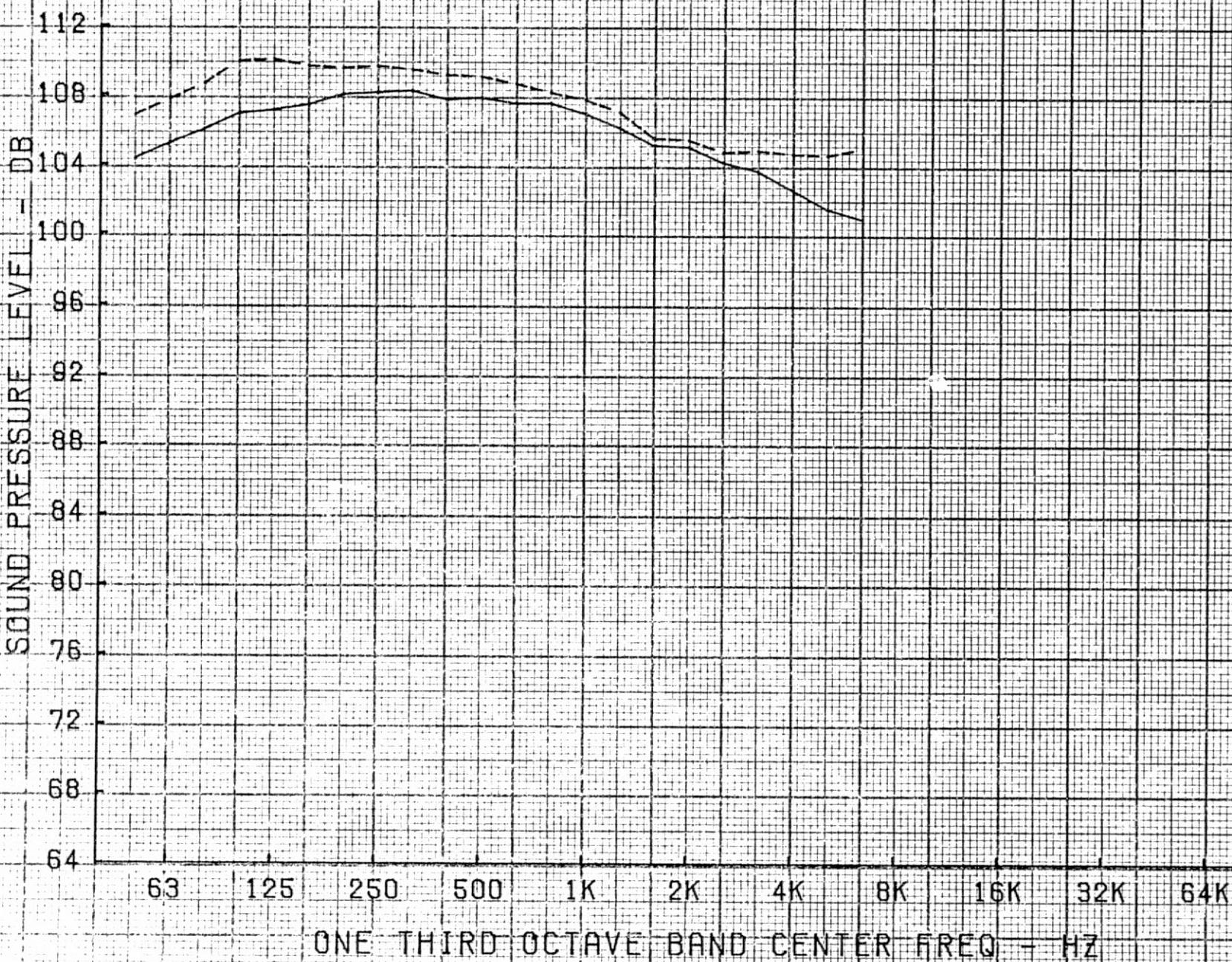
NASA VSCE (NAS3-20061) TE PT. 23
— COND 8223 DEG 150 — COND 8523 DEG 150



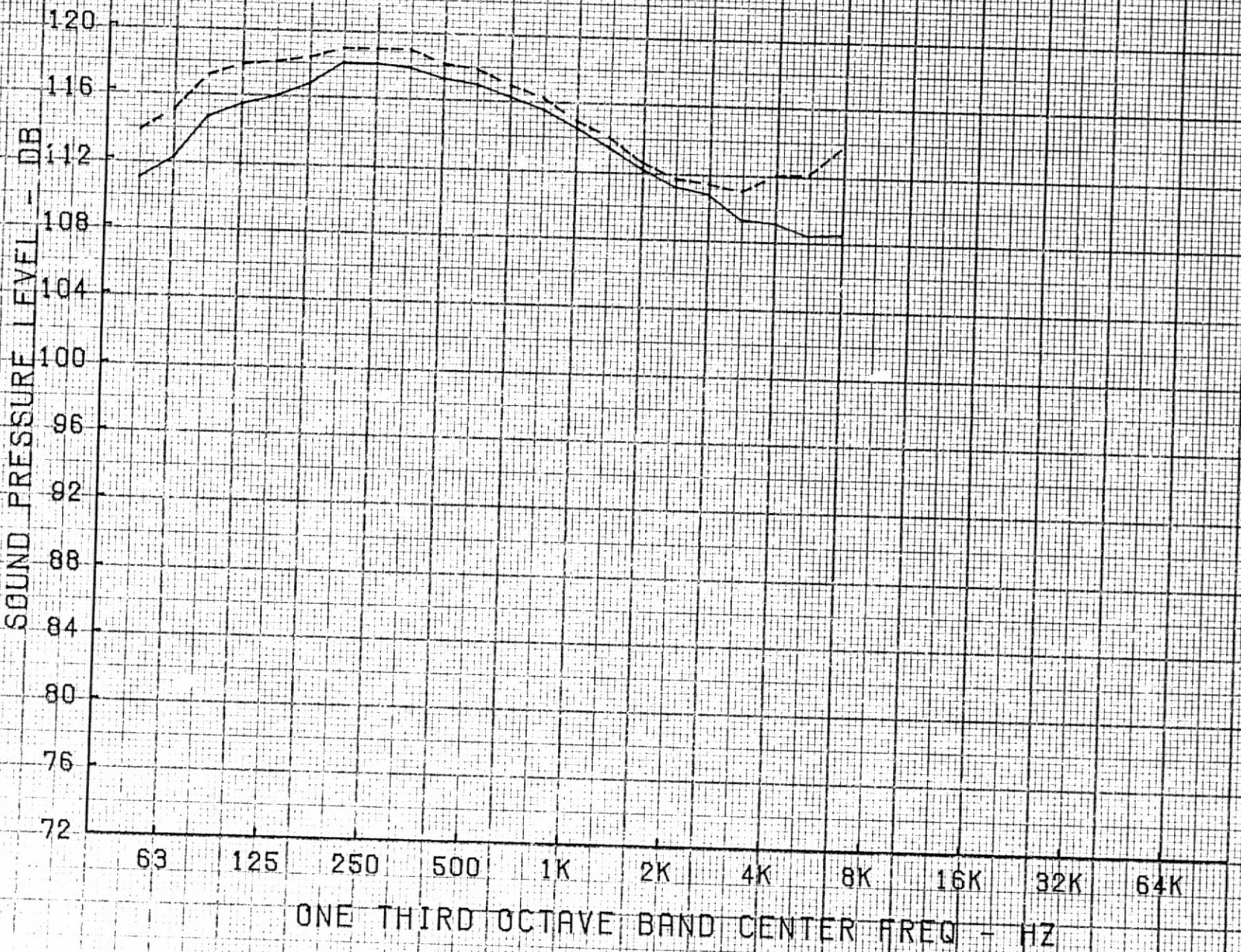
NASA VSCE (NAS3-20061) TE PT. 24

— COND 8224 DEG 90 — COND 8524 DEG 90

B-70

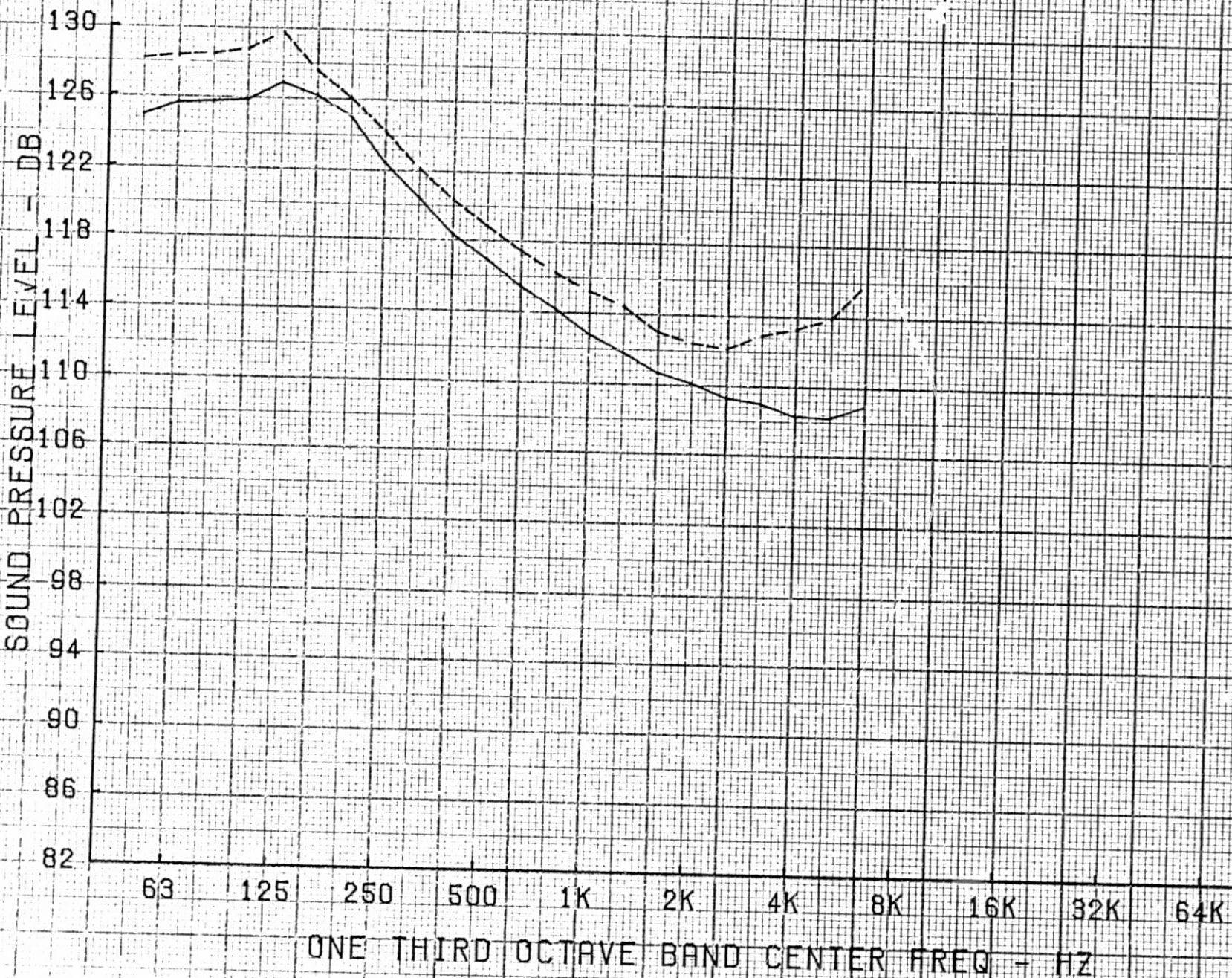


NASA VSCE (NAS3-20061) TE : PT. 24
— COND 8224 DEG 120 - - COND 8524 DEG 120

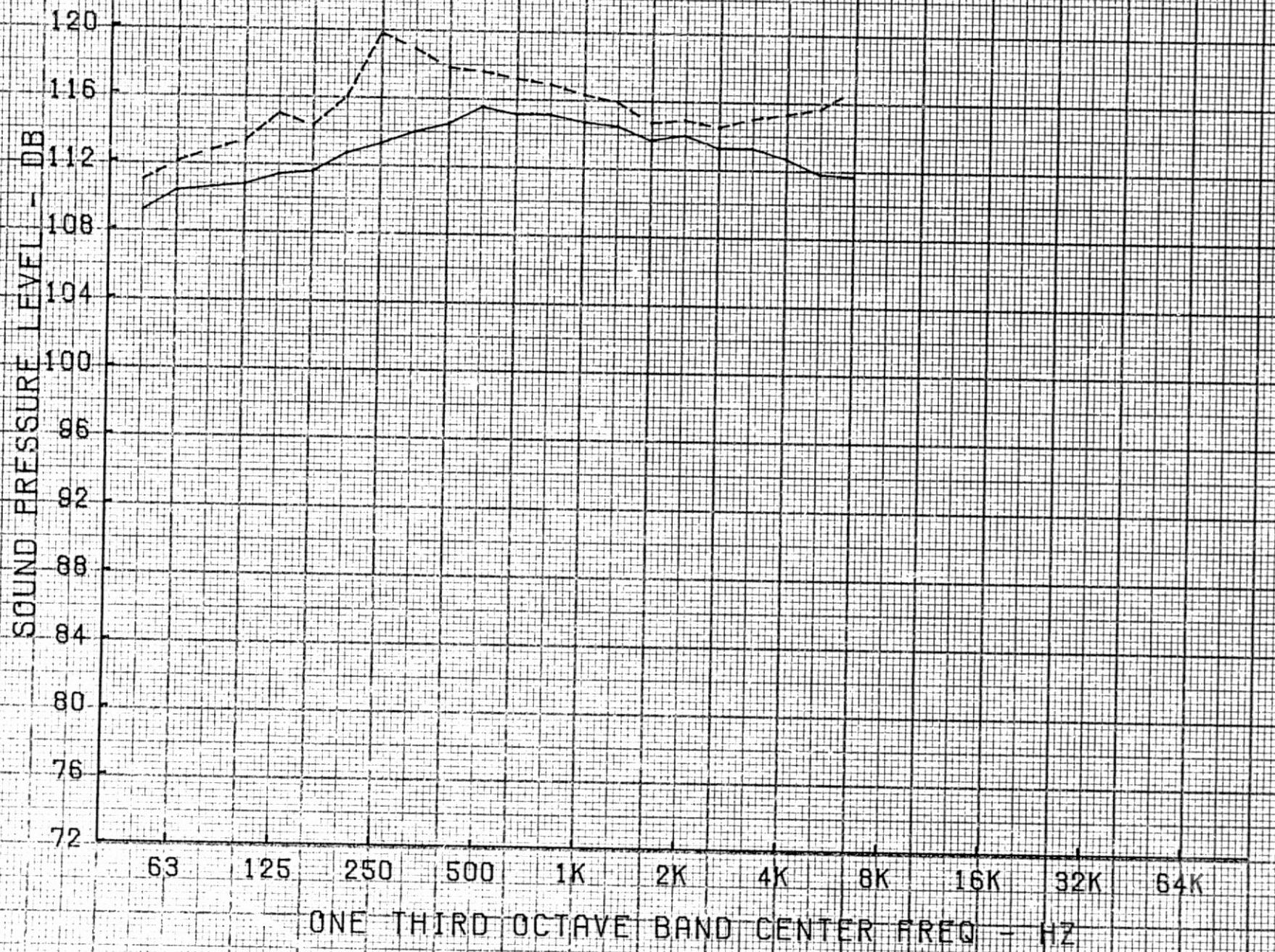


NASA VSCE (NAS3-20061) TE / PT. 24

— COND 6224 DEG 150 - - COND 8524 DEG 150



NASA VSCE (NAS3-20061) T.E.: PT. 25
— COND 8225 DEG 90 — COND 8525 DEG 90



NASA VSCE (NAS3-20061) TE PT. 25

— COND 8225 DEG 120

-- COND 8525 DEG 120

126

122

118

114

110

106

102

98

94

90

86

82

78

SOUND PRESSURE LEVEL - DB

63

125

250

500

1K

2K

4K

8K

16K

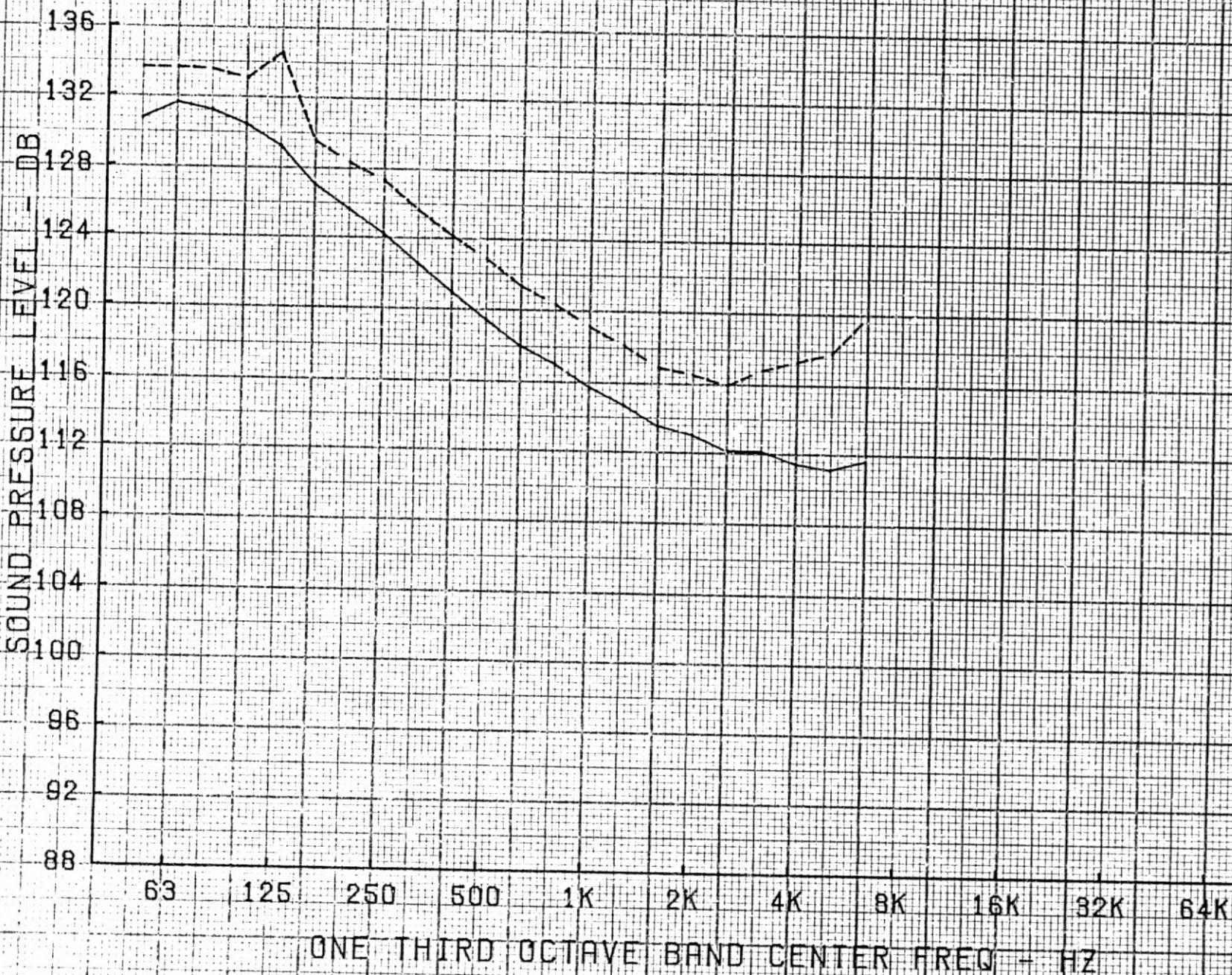
32K

64K

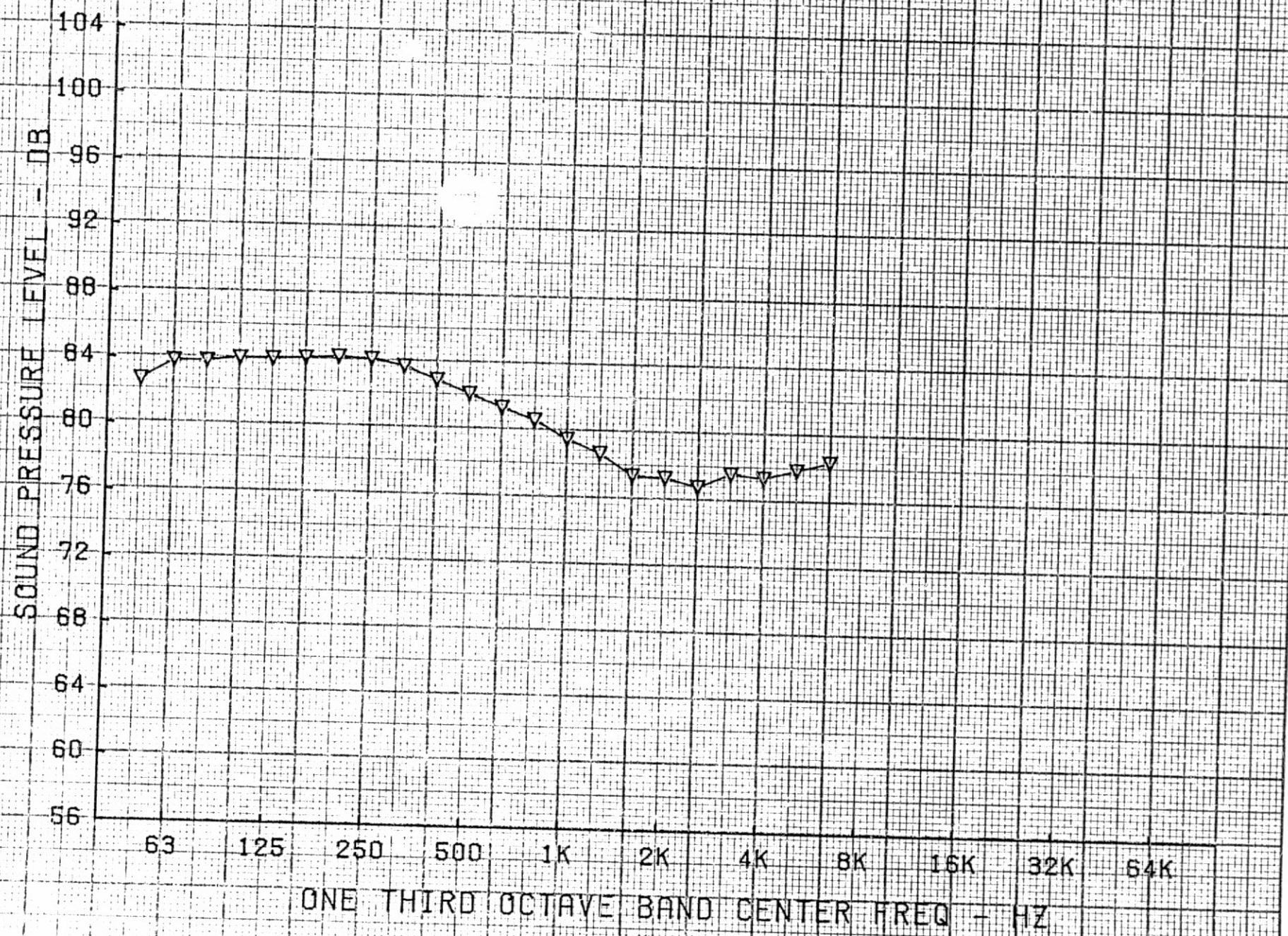
ONE THIRD OCTAVE BAND CENTER FREQ - Hz

NASA VSCE (NAS3-20061) TF / PT. 25

— COND 8225 DEG 160 — COND 8525 DEG 160

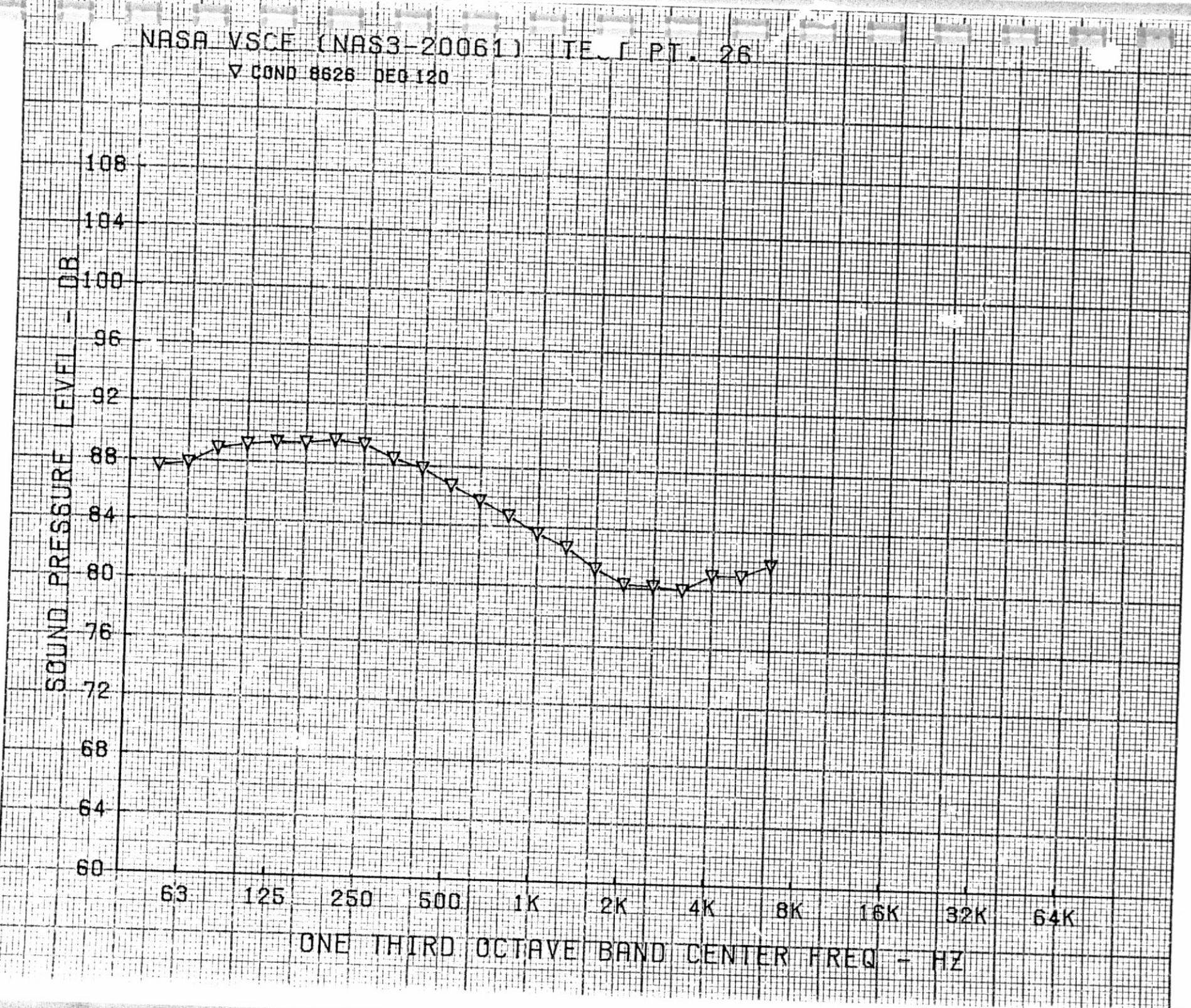


NASA VSCE (NAS3-20061) TE, PT. 26
▽ COND 8626 DEG 90



NASA VSCE (NAS3-20061) TEF PT. 26
▽ COND 8626 DEG 120

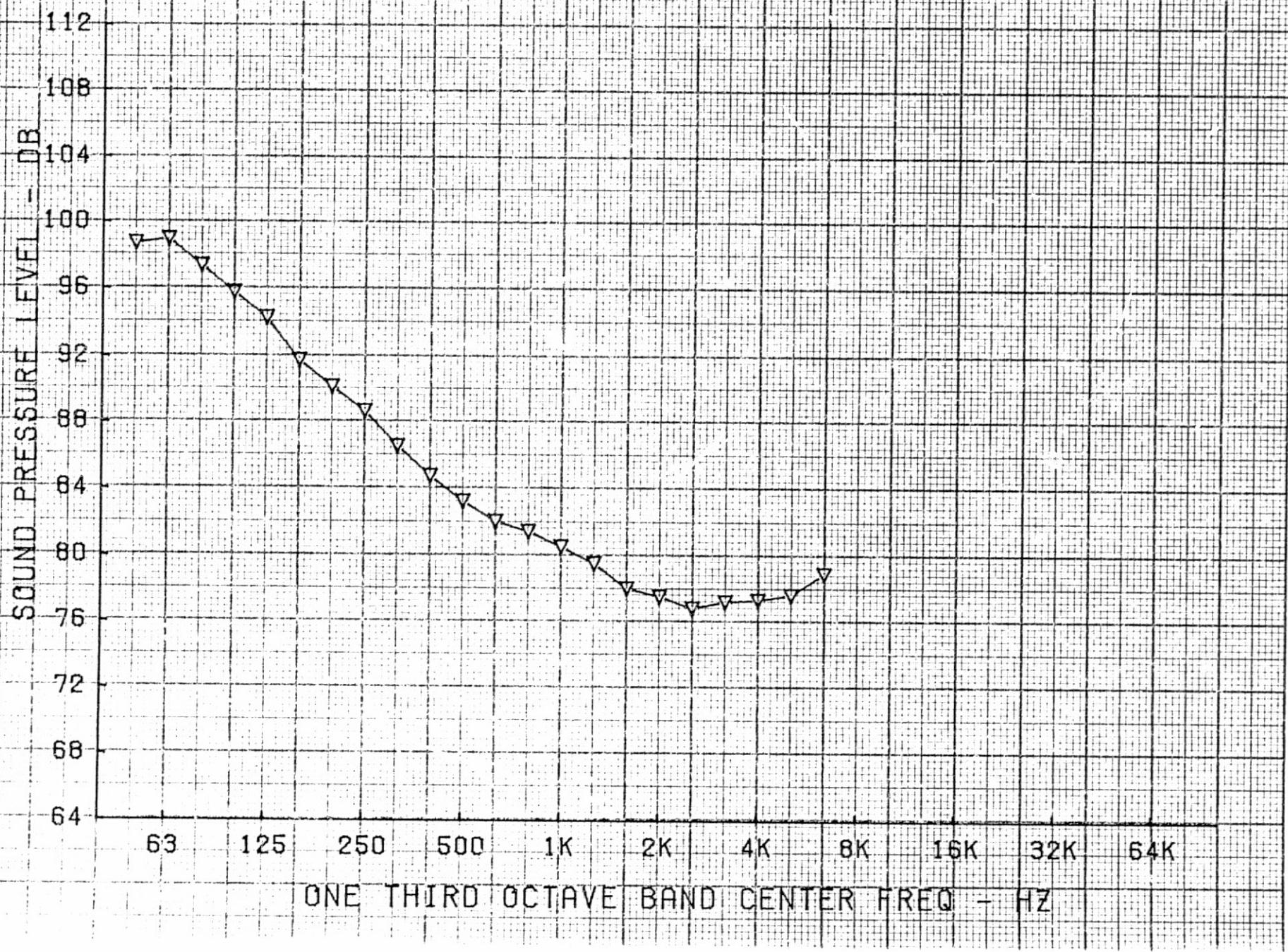
B-77



NASA VSCE (NAS3-20061) TEJ PT. 26

▽ COND 8626 DEG 150

B-78



NASA VSCE (NAS3-20061) TE, F PT. 27
▽ COND 8627 DEG 90

B-79



NASA VSCE (NAS3-20061) TE PT. 27
▽ COND 8627 DEG 120

B-80



NASA VSCE (NAS3-20061) TEJ PT. 27
V COND 8627 DEG 150

B-81

SOUND PRESSURE LEVEL - dB

128
124
120
116
112
108
104
100
96
92
88
84
80

63 125 250 500 1K 2K 4K 8K 16K 32K 64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz

V COND 8627 DEG 150

NASA

VSCE (NAS3-20061)

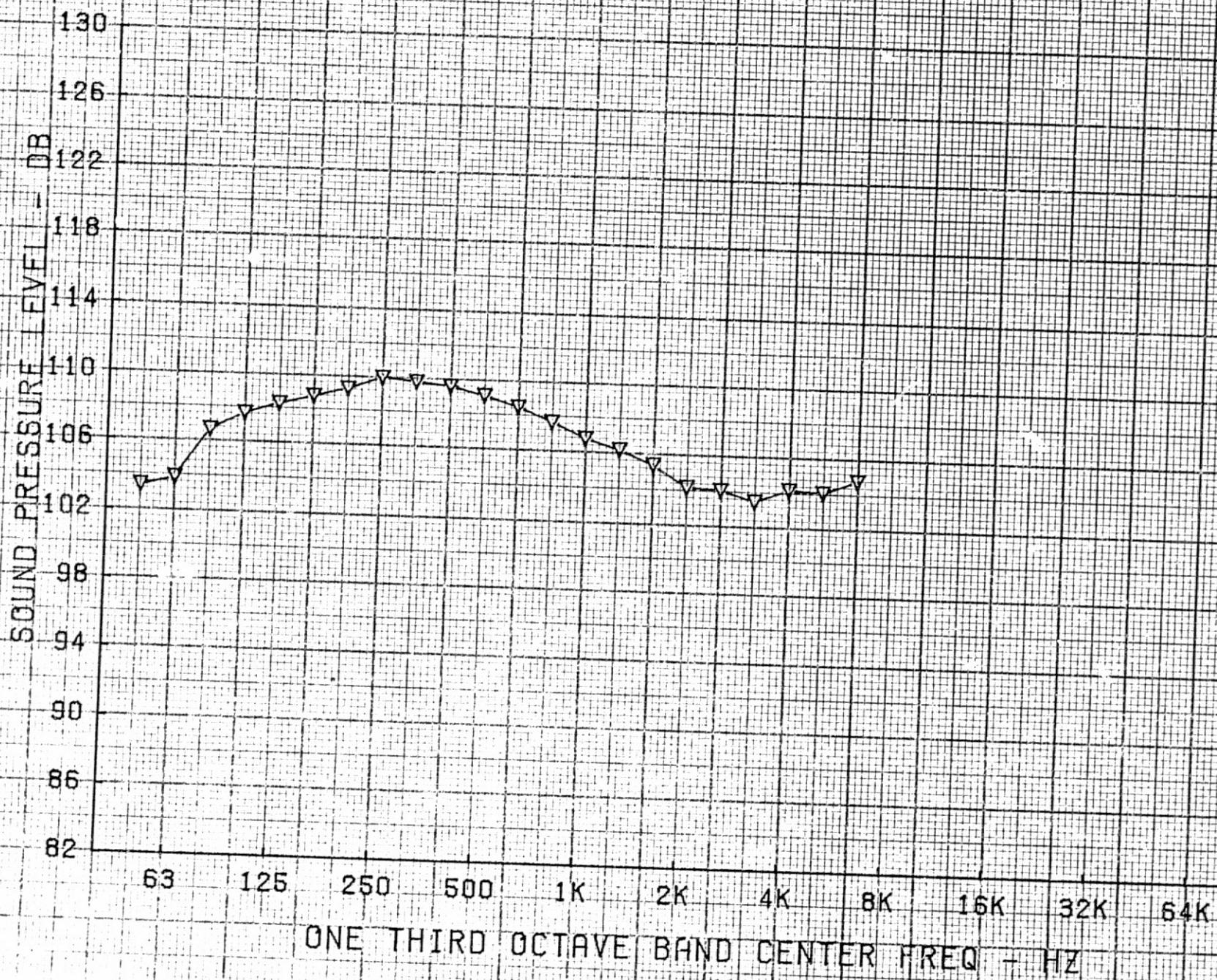
TEJ PT. 27

DEG 150

NASA VSCE (NP33-20061) TE PPT 28
▽ COND E628 DEG 90

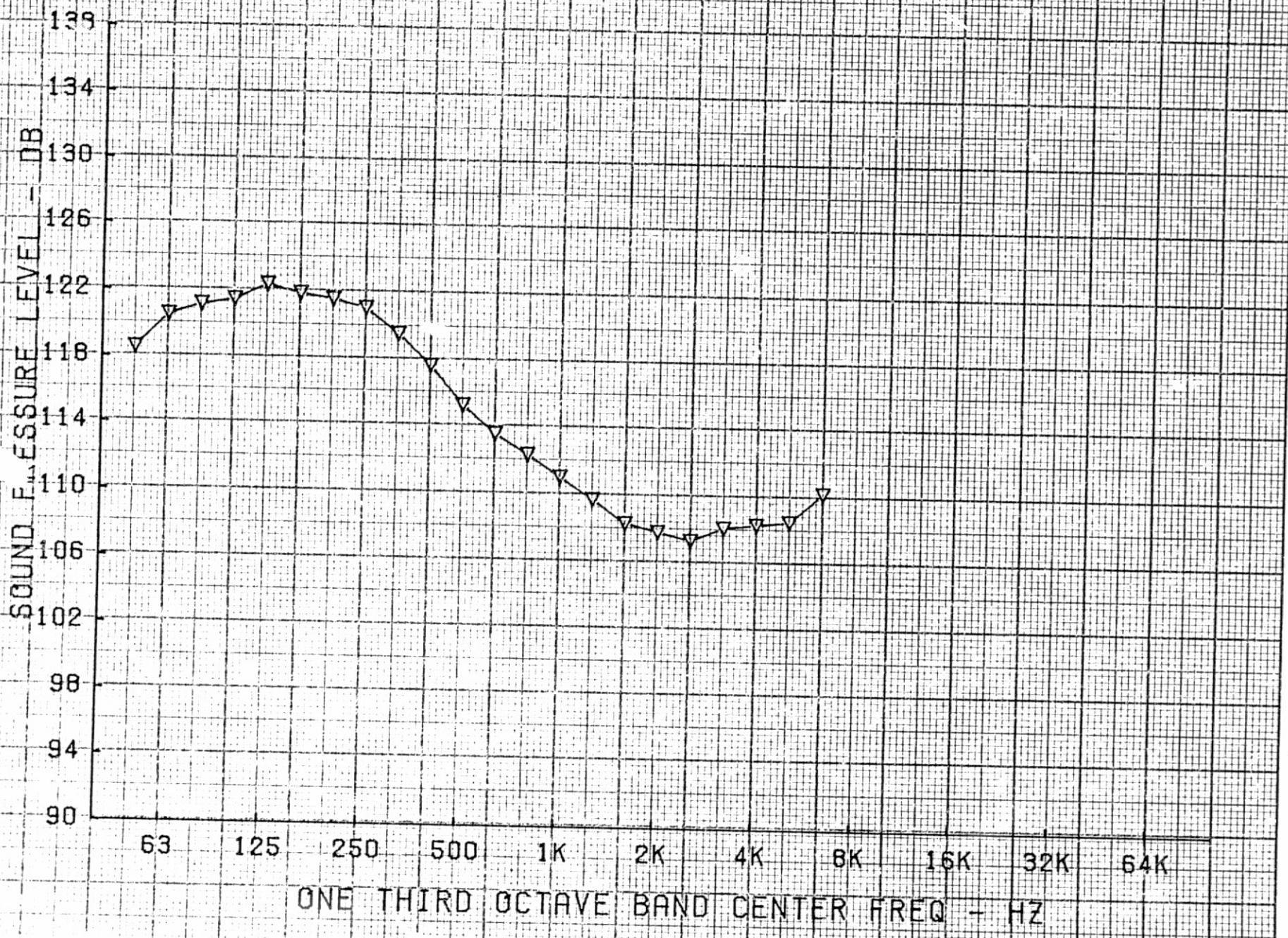


NASA VSCE (NAS3-20061) TE. PT. 28
▽ COND 8628 DEG 120



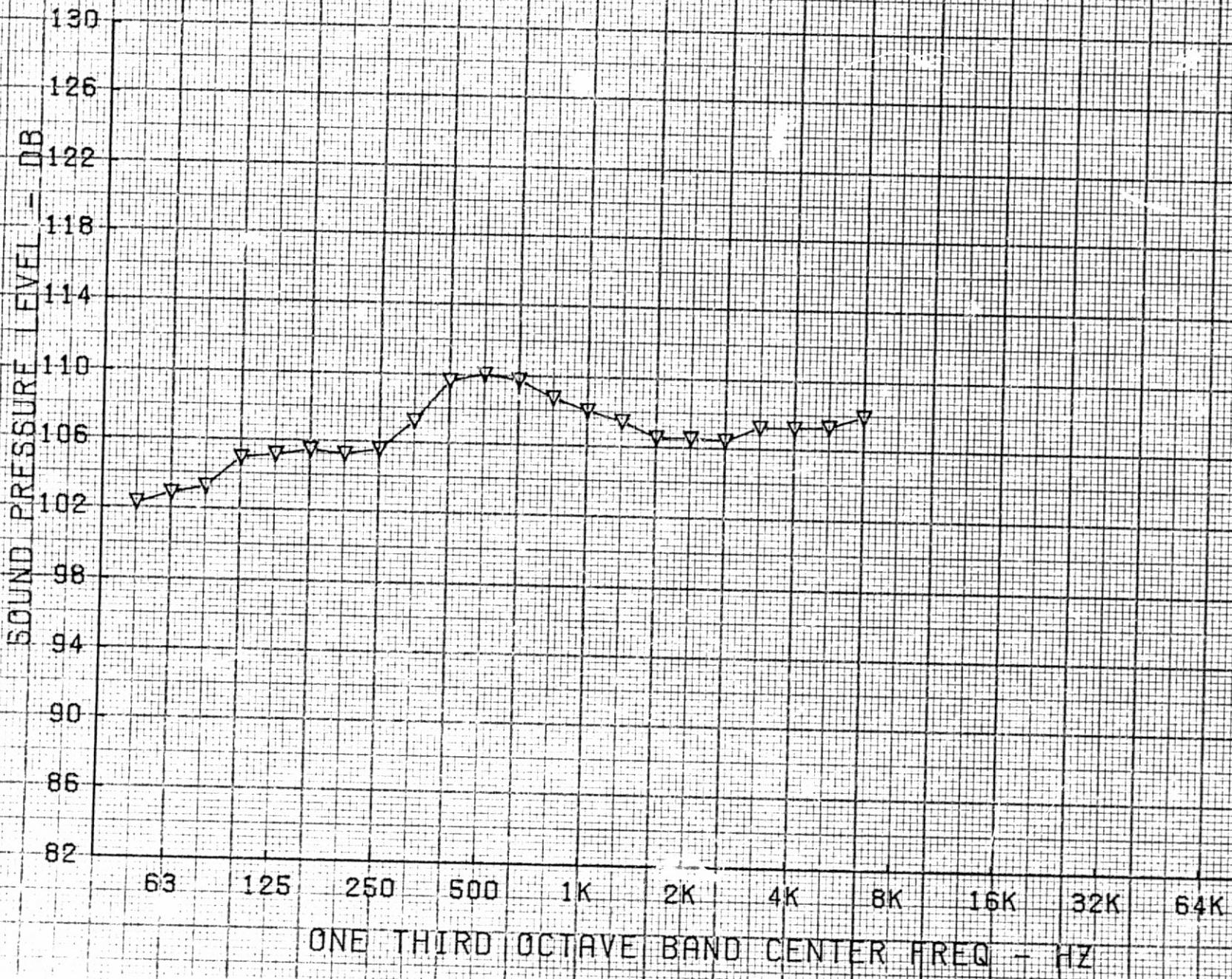
NASA VSCE (NAS3-20061) TE PT. 28
▽ COND 8628 DEG 150

B-84



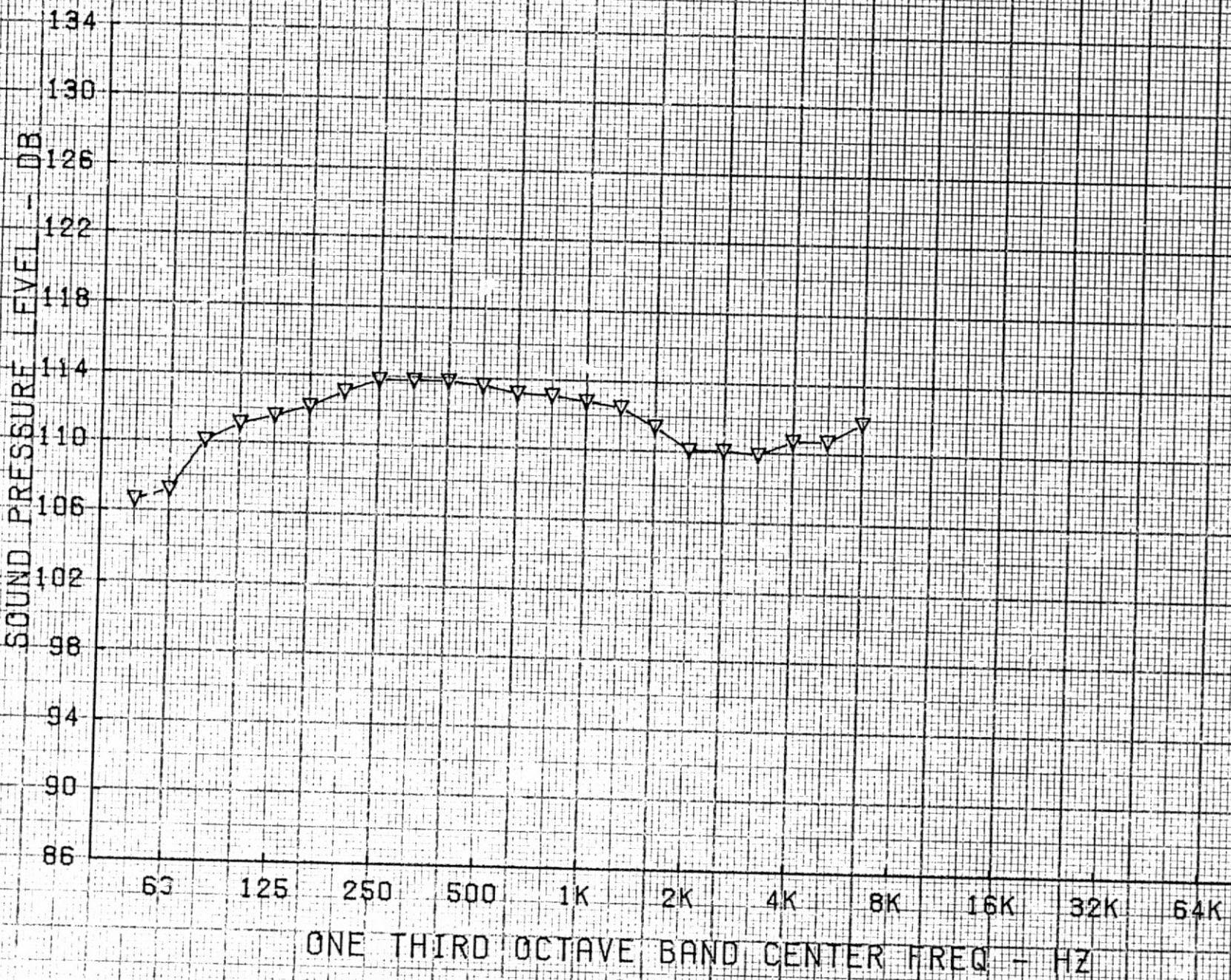
NASA VSCE (NAS3-20061) TE FPT. 29
▽ COND 8629 DEG 90

B-85



NASA VSCE (NAS3-20061) TE F PT. 29

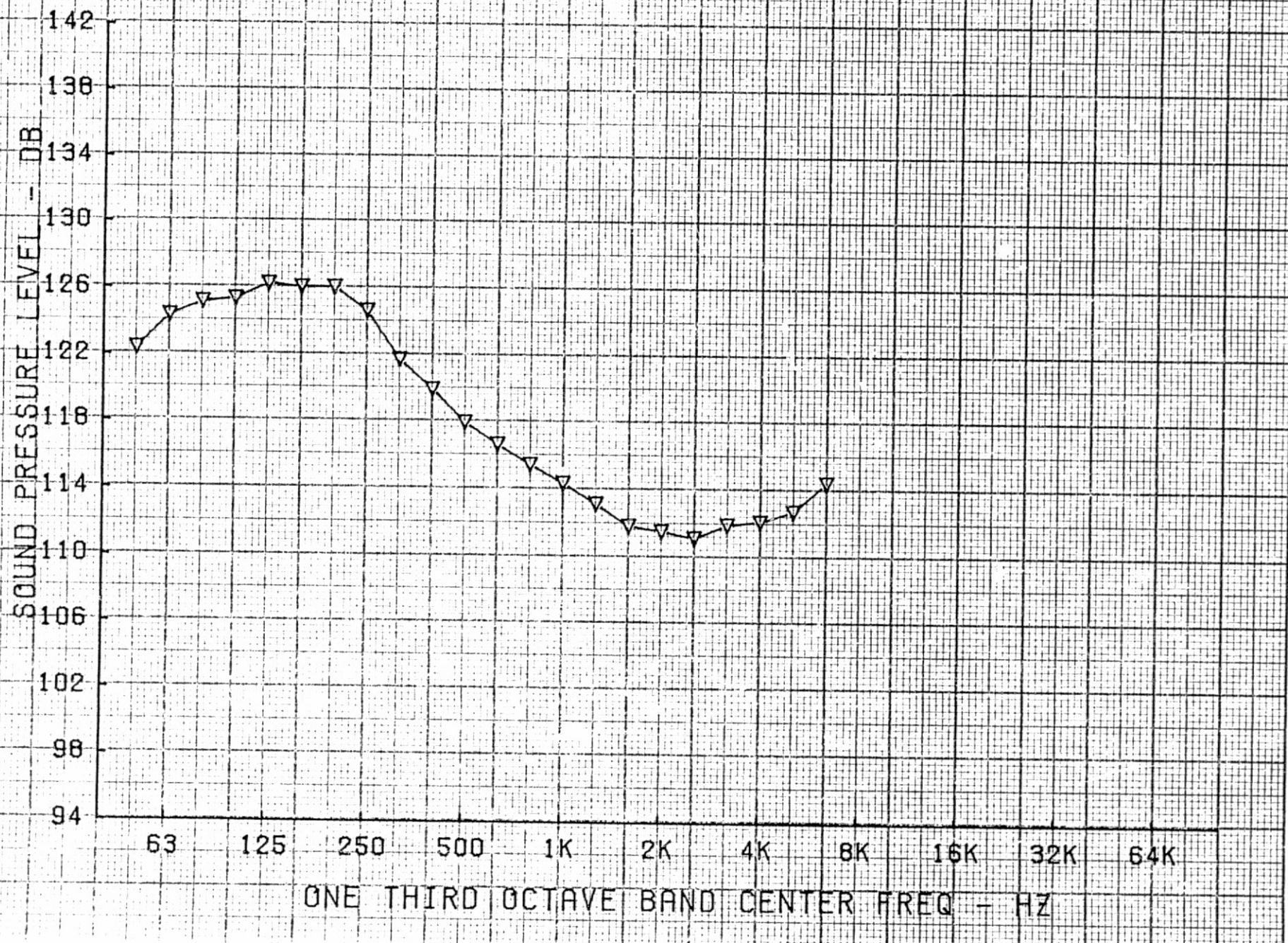
▽ COND 6629 DEG 120



NASA VSCE (NAS3-20061) T E T PT. 29

▽ COND 8629 DEG 150

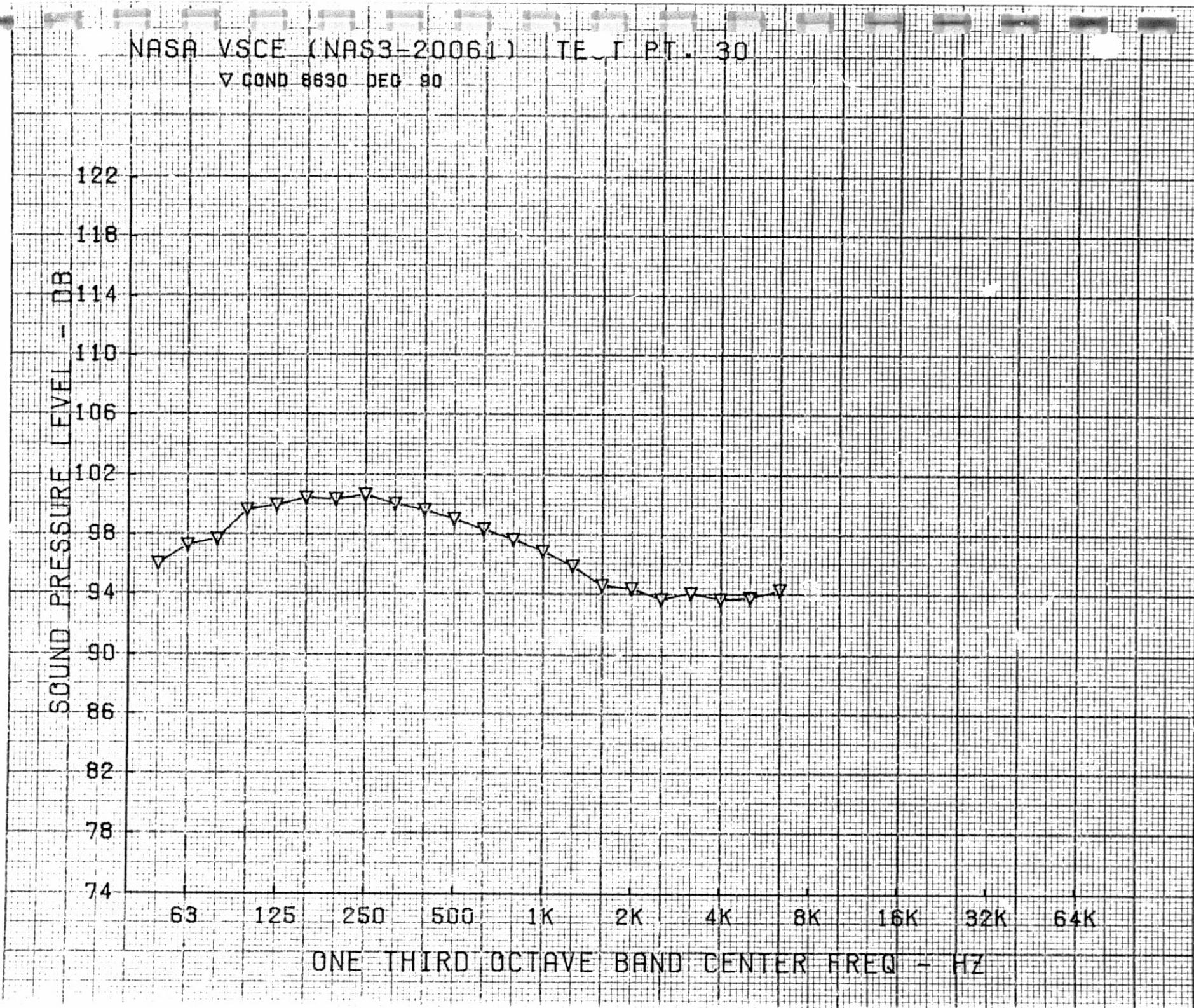
B-87



NASA VSCE (NAS3-20061) TE-T PT. 30

▽ COND 8630 DEG 90

B-88



NASA VSCE (NAS3-20061) TF I PT. 30

▽ COND 8630 DEG 120

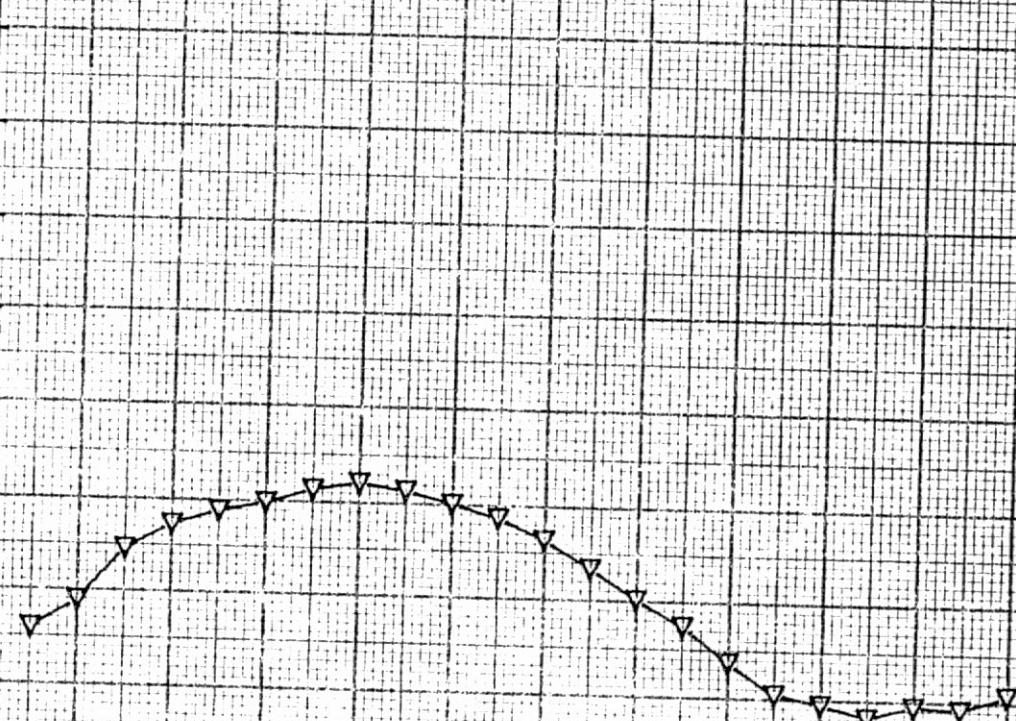
68-B

128
124
120
116
112
108
104
100
96
92
88
84
80

SOUND PRESSURE LEVEL - DB

63 125 250 500 1K 2K 4K 8K 16K 32K 64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz



NASA VSCE (NAS3-20061) TEST PT. 30
▽ COND 8630 DEG 150

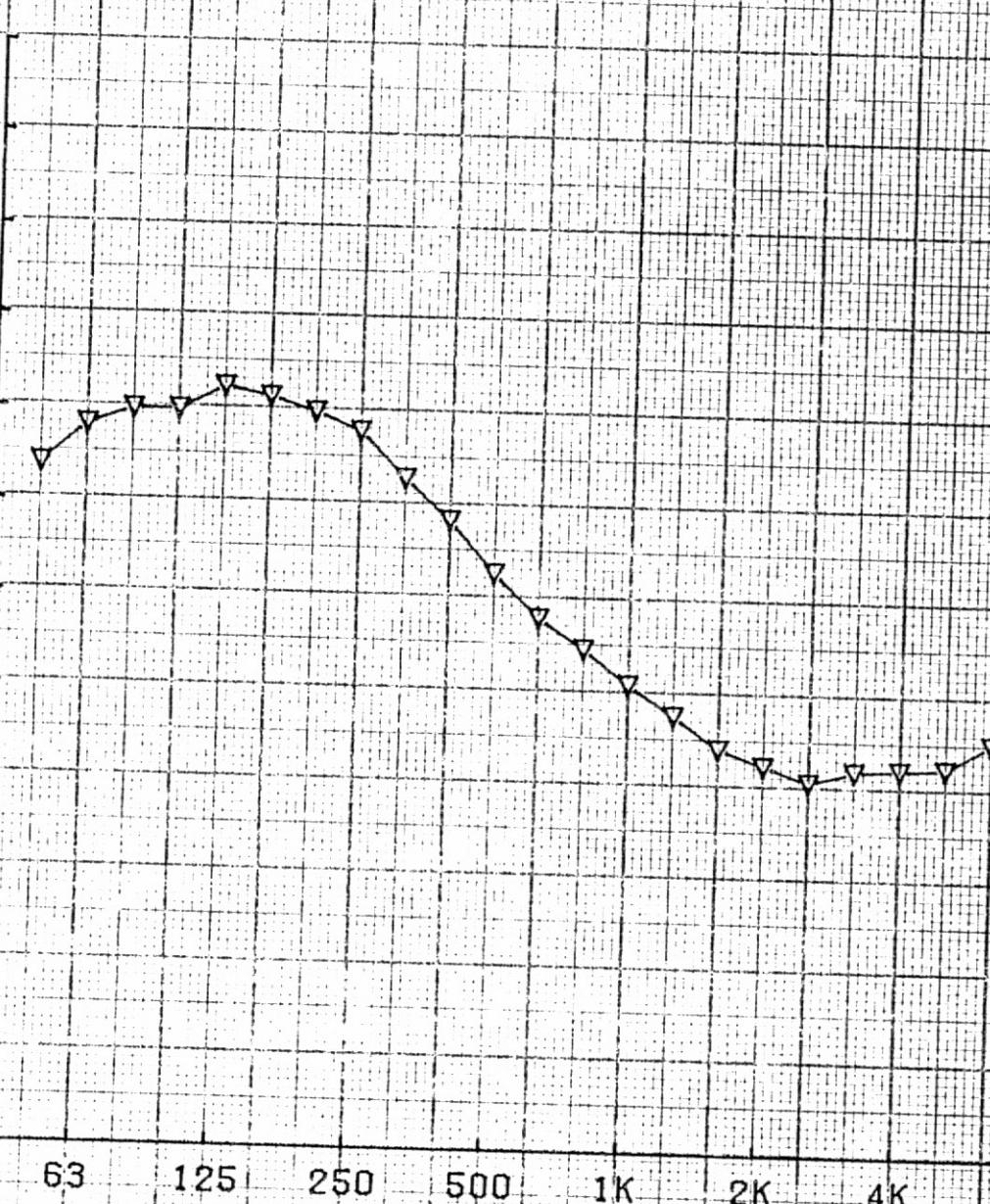
06-8

SOUND PRESSURE LEVEL - DB

134
130
126
122
118
114
110
106
102
98
94
90
86

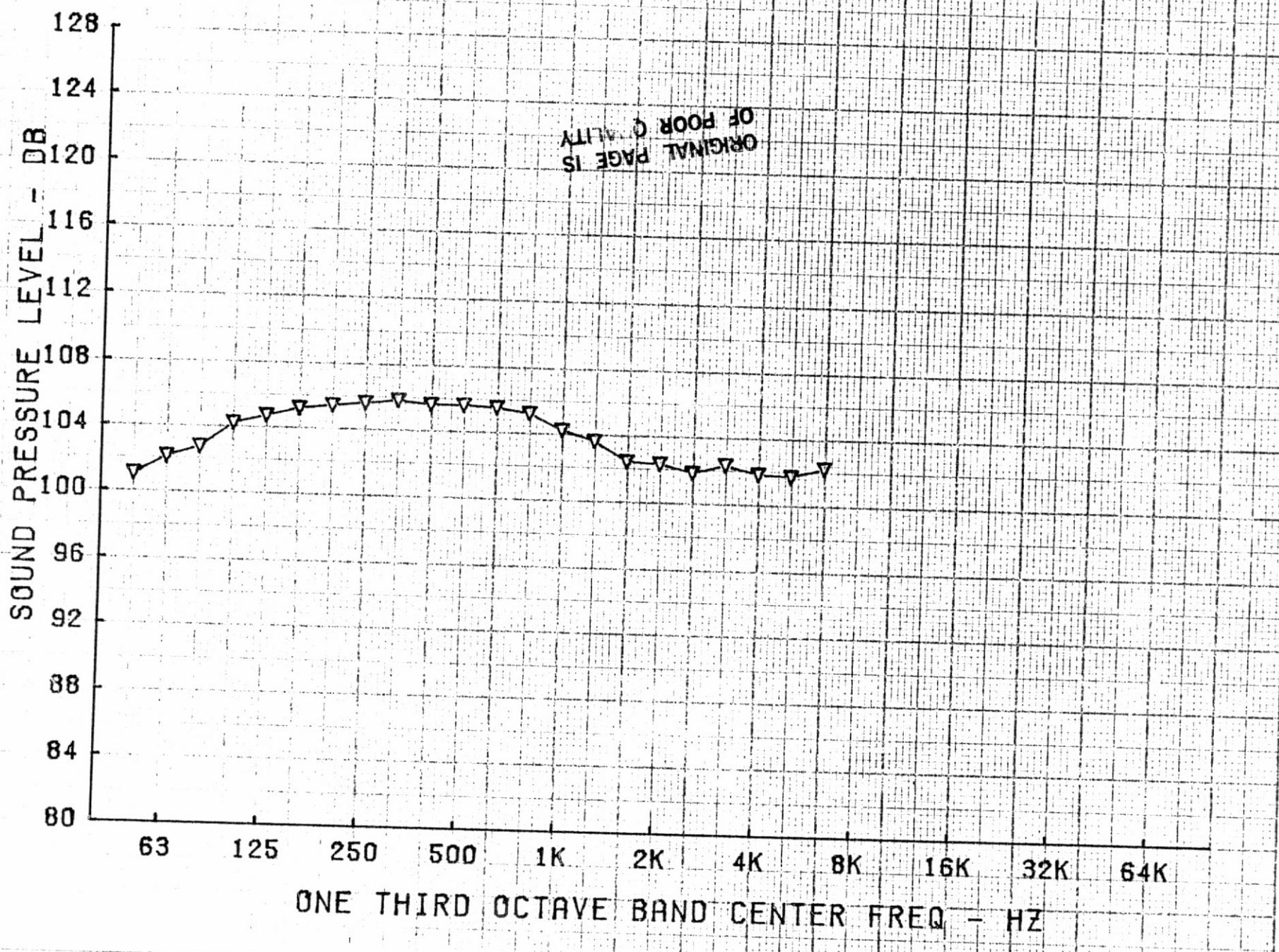
63 125 250 500 1K 2K 4K 8K 16K 32K 64K

ONE THIRD OCTAVE BAND CENTER FREQ - Hz

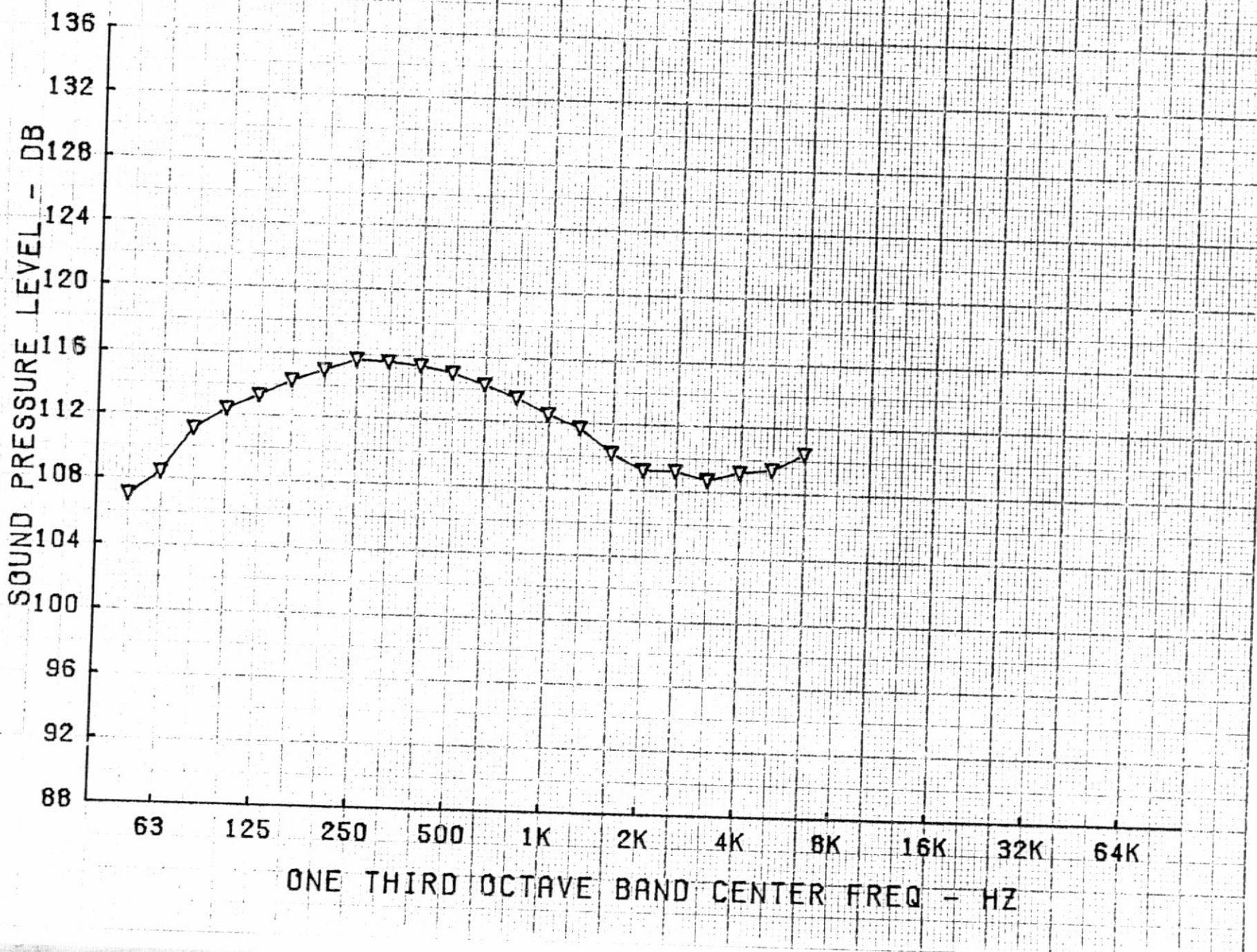


NASA VSCE (NAS3-20061) TE I PT. 31

▽ COND 8631 DEG 90



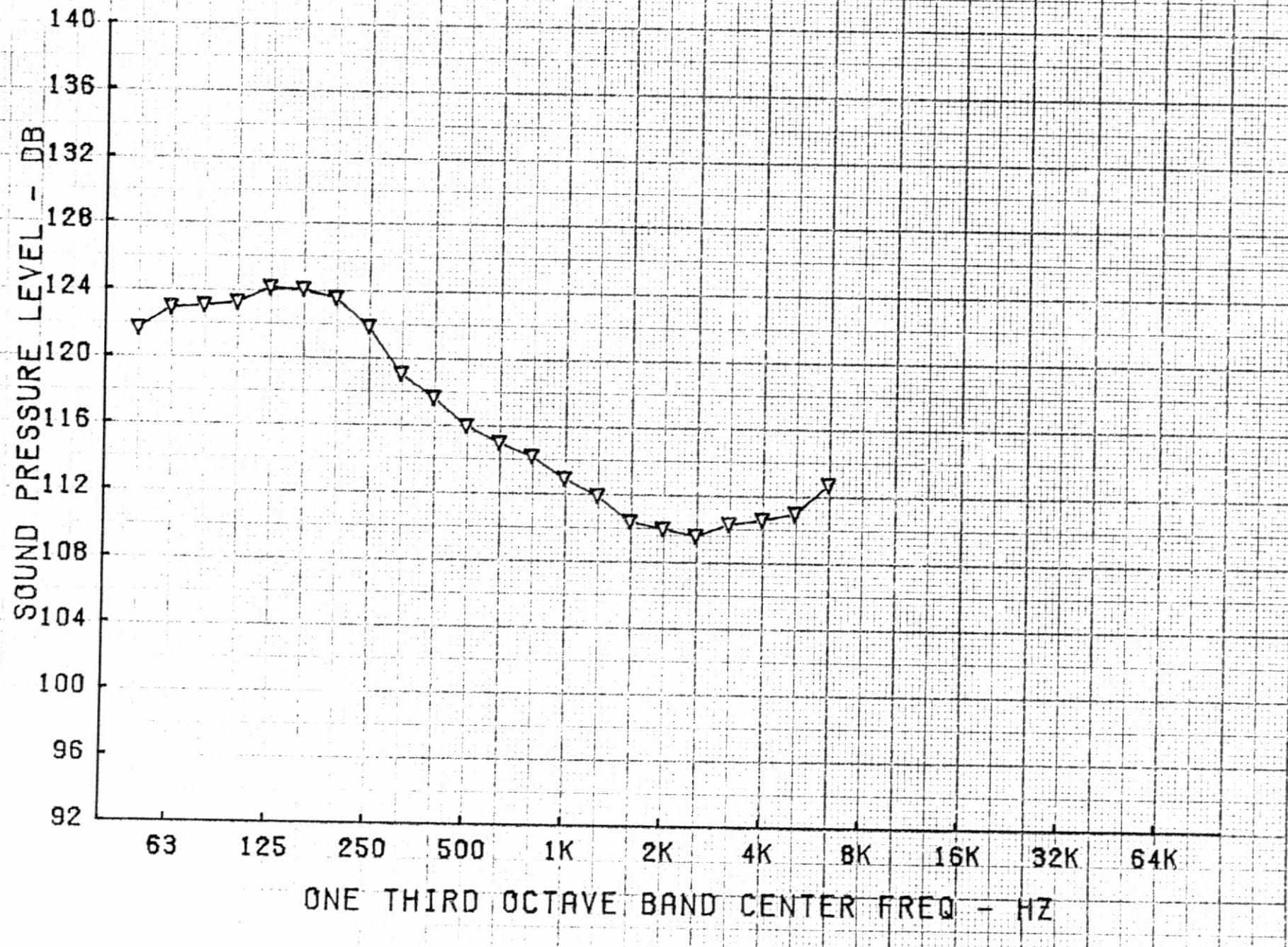
NASA VSCE (NAS3-20061) TE I PT. 31
▼ COND 8831 DEG 120



NASA VSCE (NAS3-20061) TEC PT. 31

▽ COND 8631 DEG 150

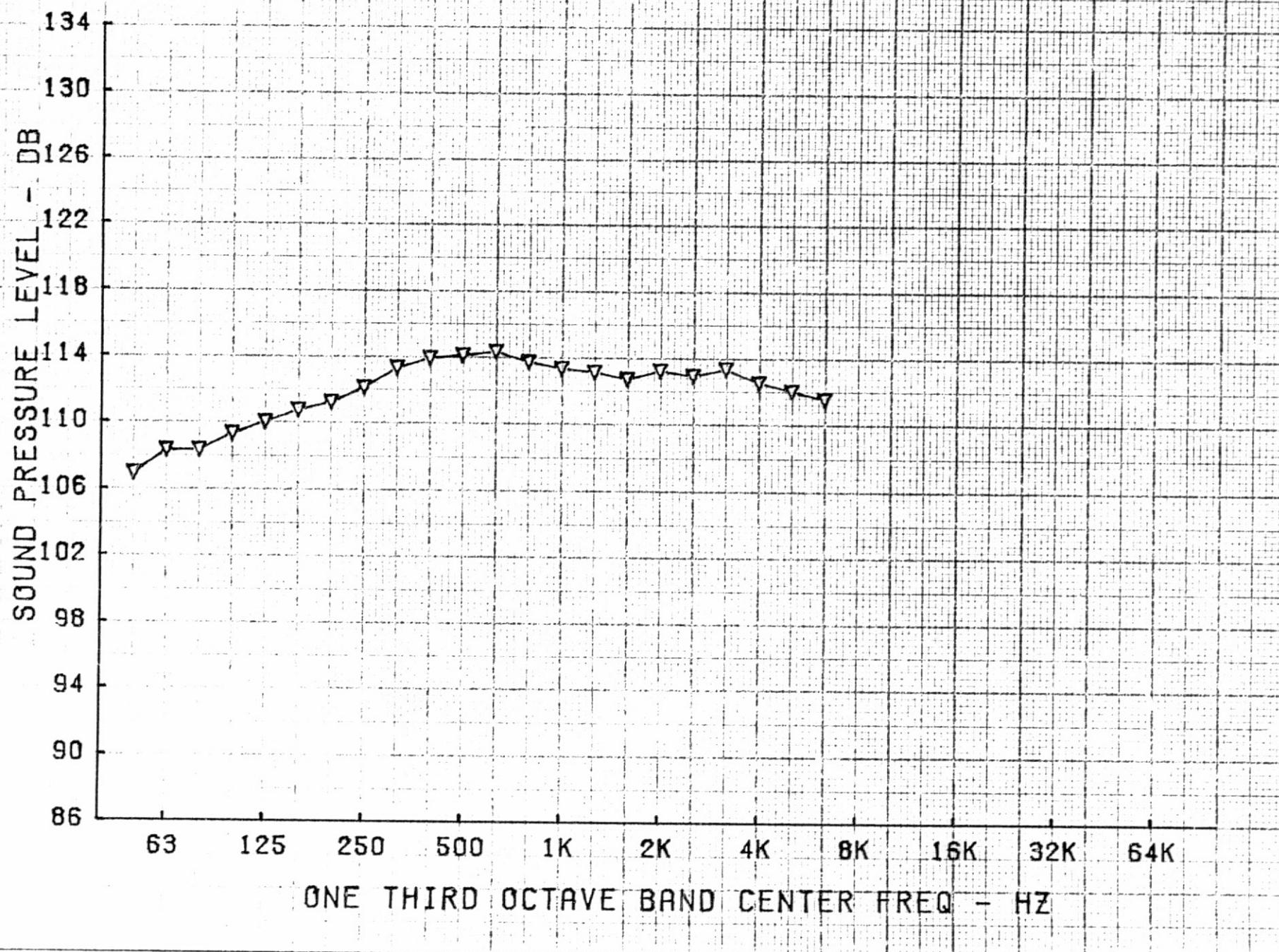
E-93



NASA VSCE (NAS3-20061) TEL. PT. 32

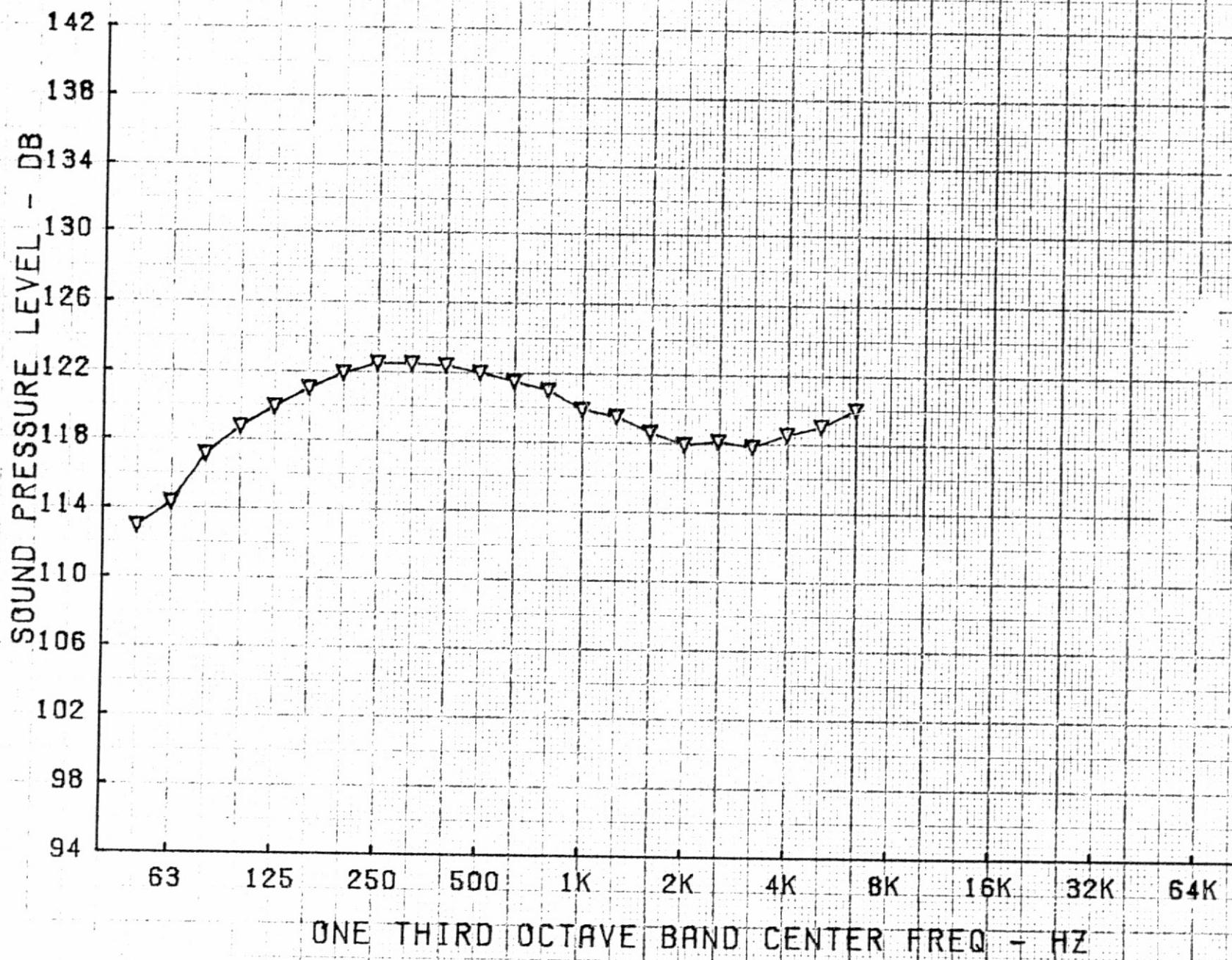
▽ COND 8632 DEG 90

B-94



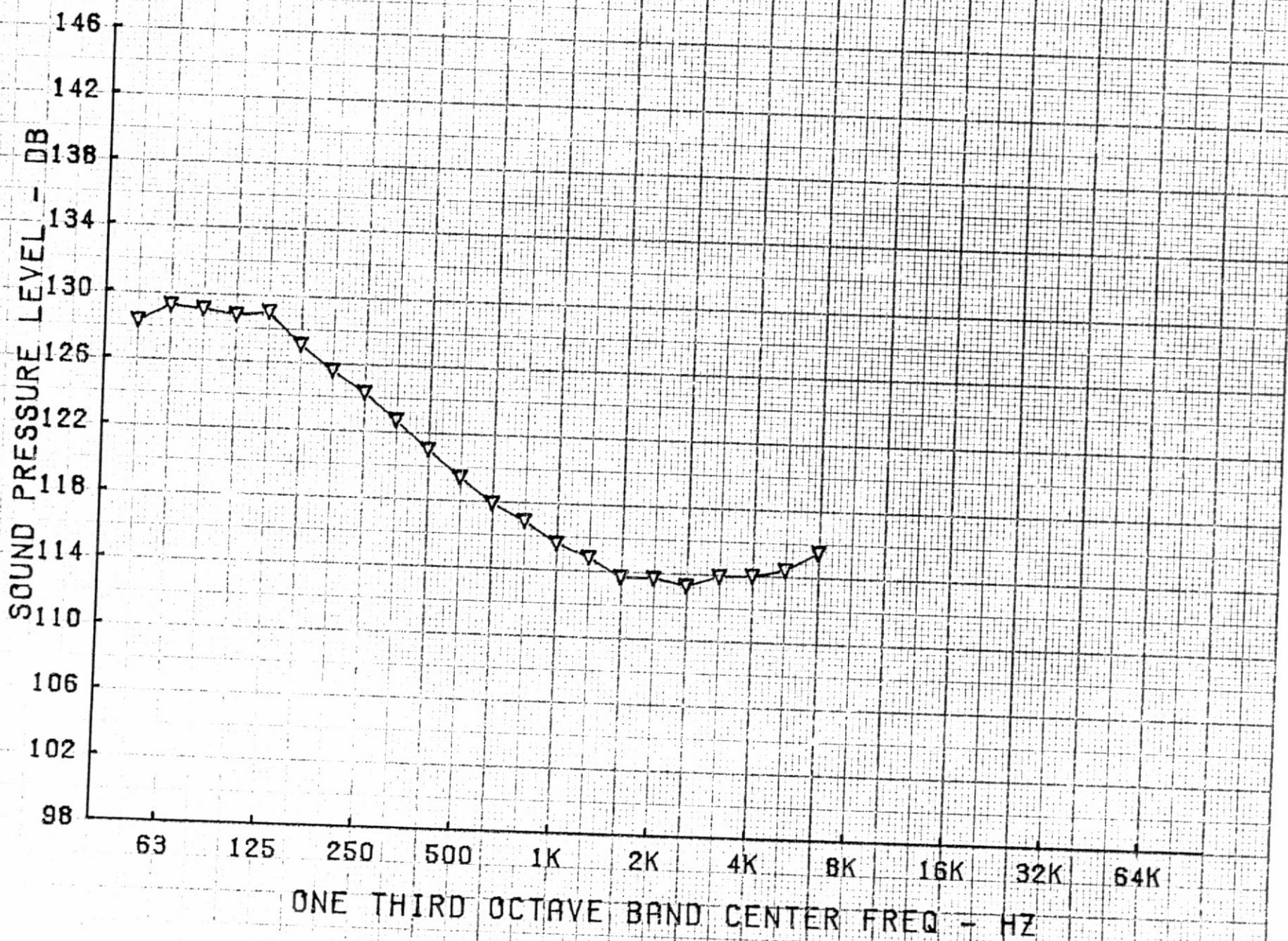
NASA VSCE (NAS3-20061) TE. PT. 32

▽ COND 8632 DEG 120

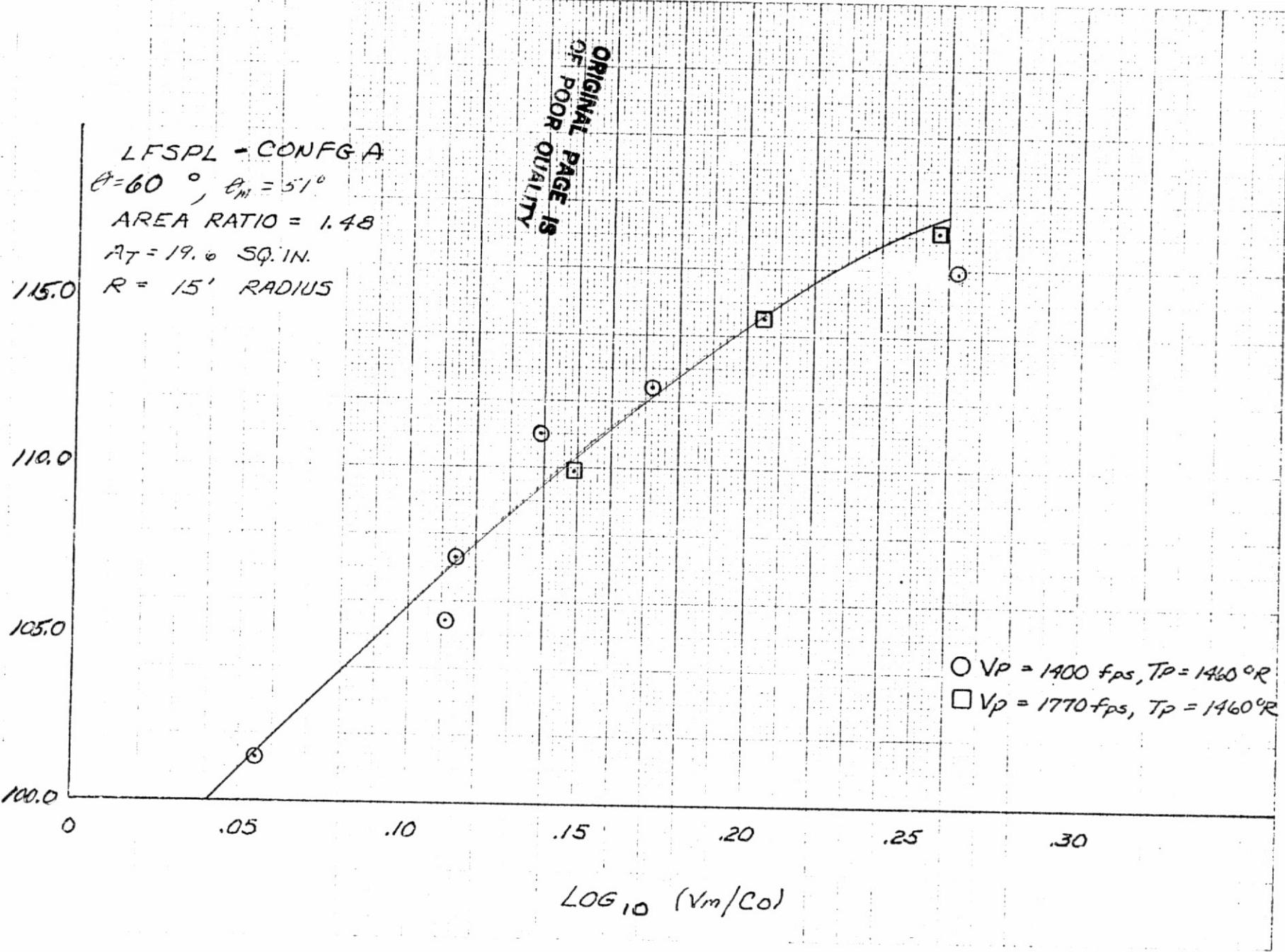


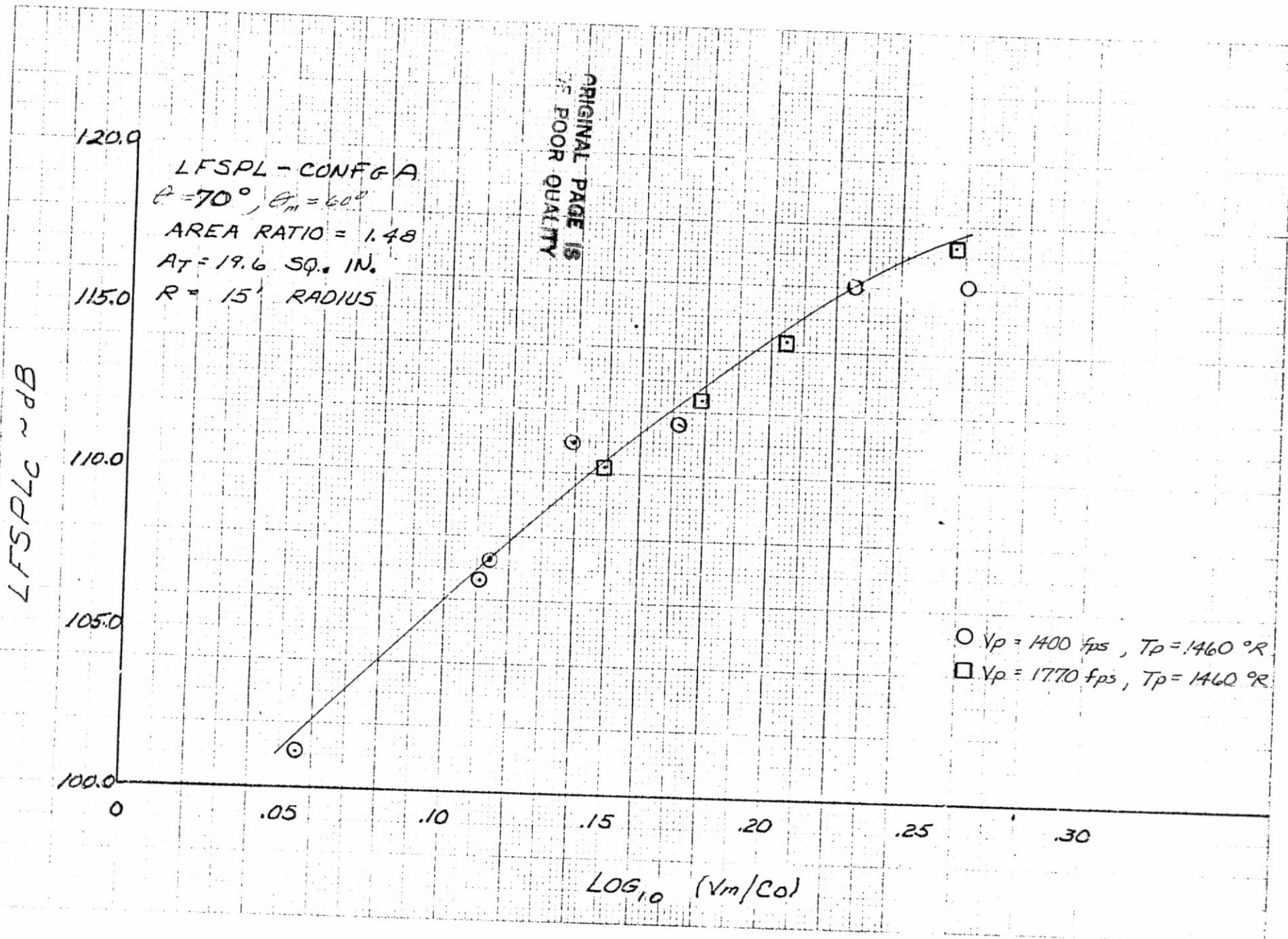
NASA VSCE (NAS3-20061) TE PT. 32
▽ COND 8632 DEG 150

B-96



C-1





120.0

LFSPL - CONFIG A

 $\theta = 80^\circ, \theta_m = 70^\circ$

AREA RATIO = 1.48

AT = 19.6 SQ. IN.

R = 15' RADIUS

C-3

 $L_{FSPL} \approx dB$

100.0

105.0

110.0

115.0

120.0

0

.05

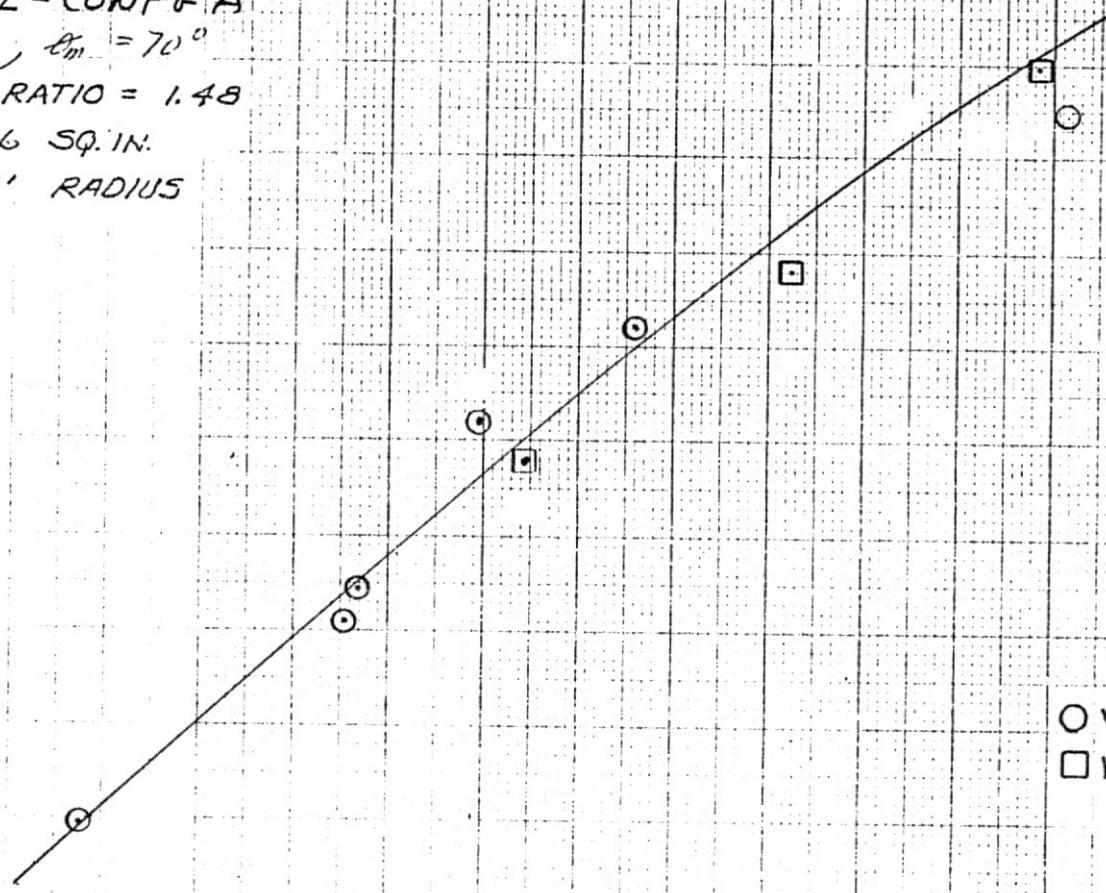
.10

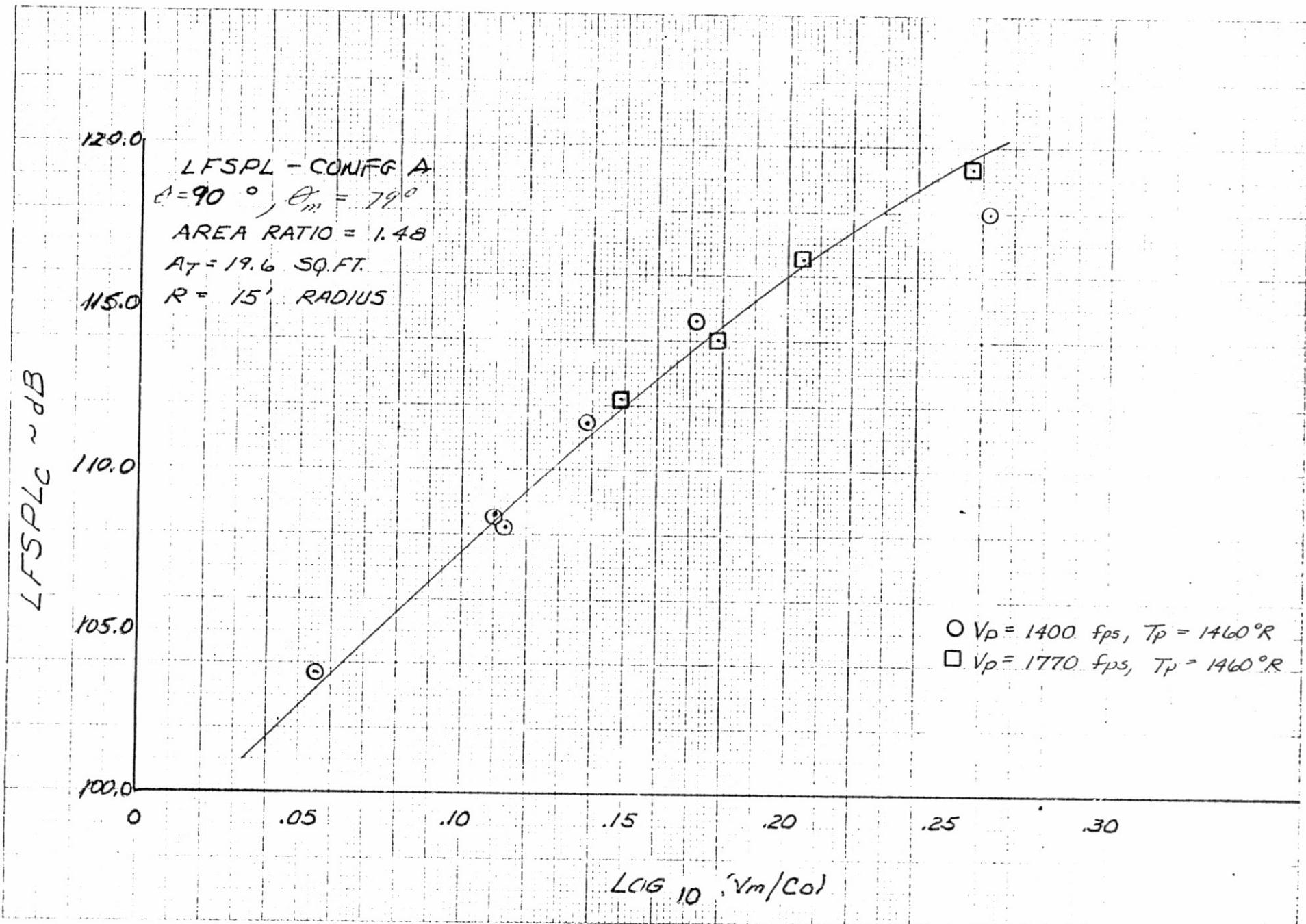
.15

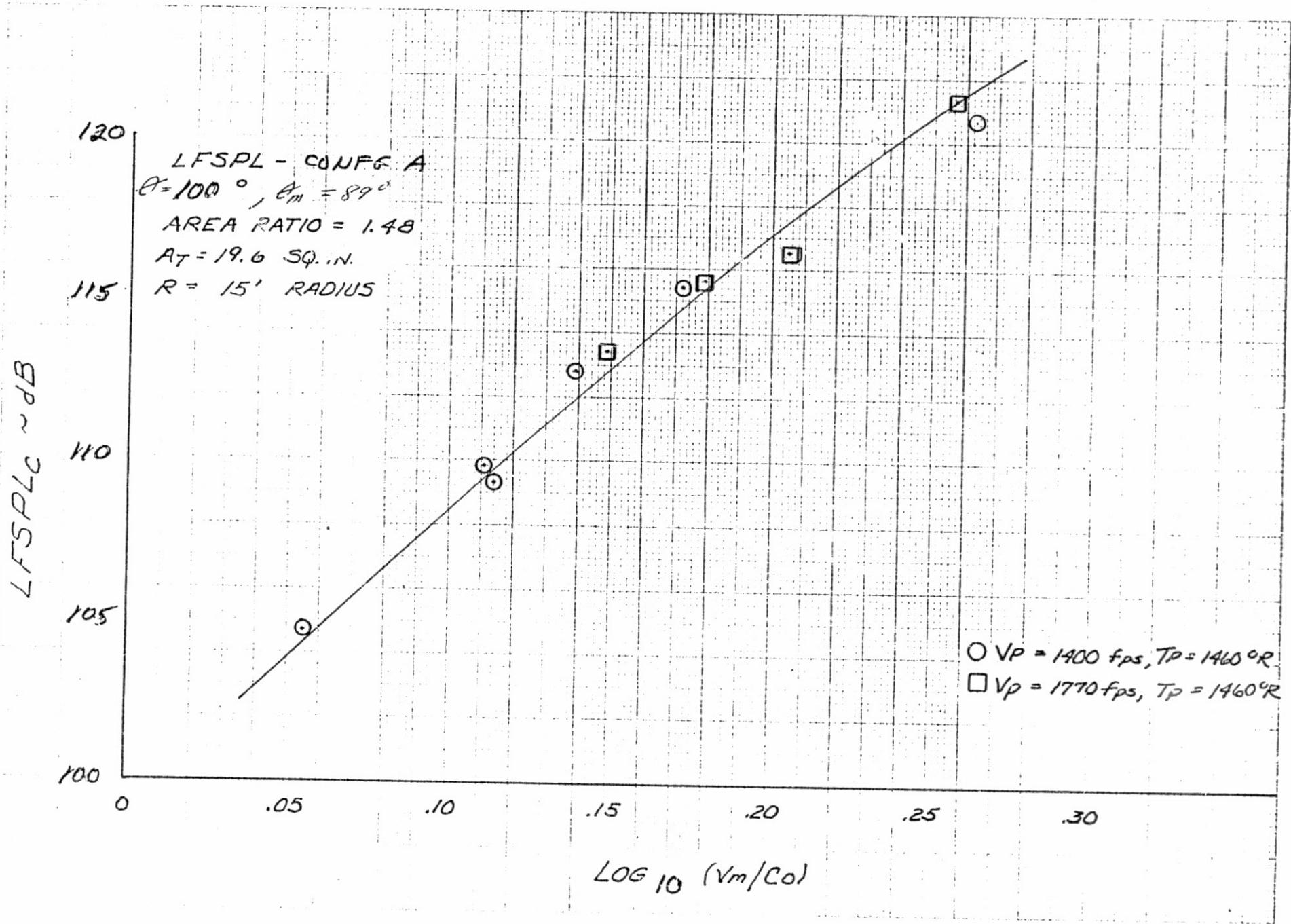
.20

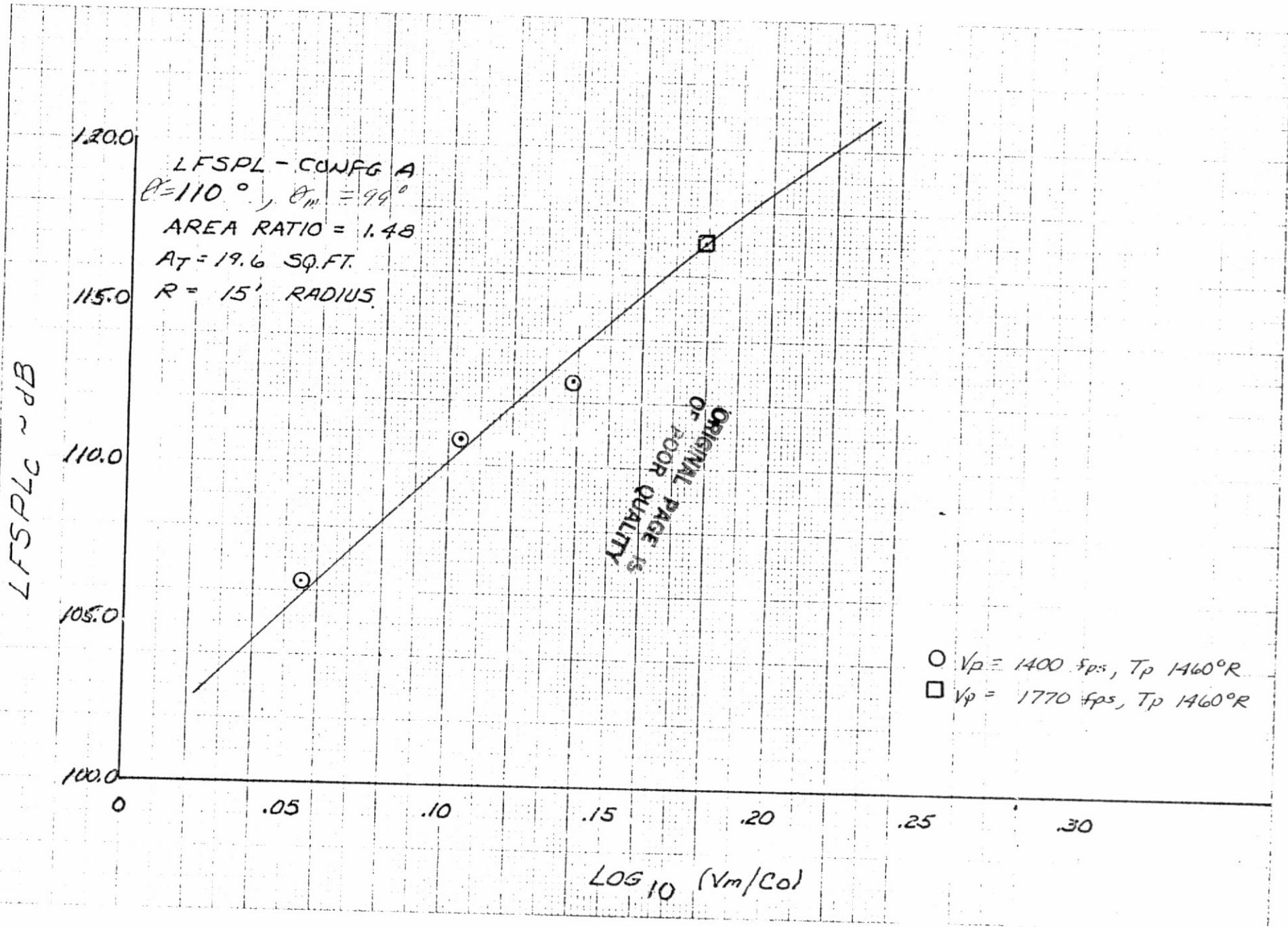
.25

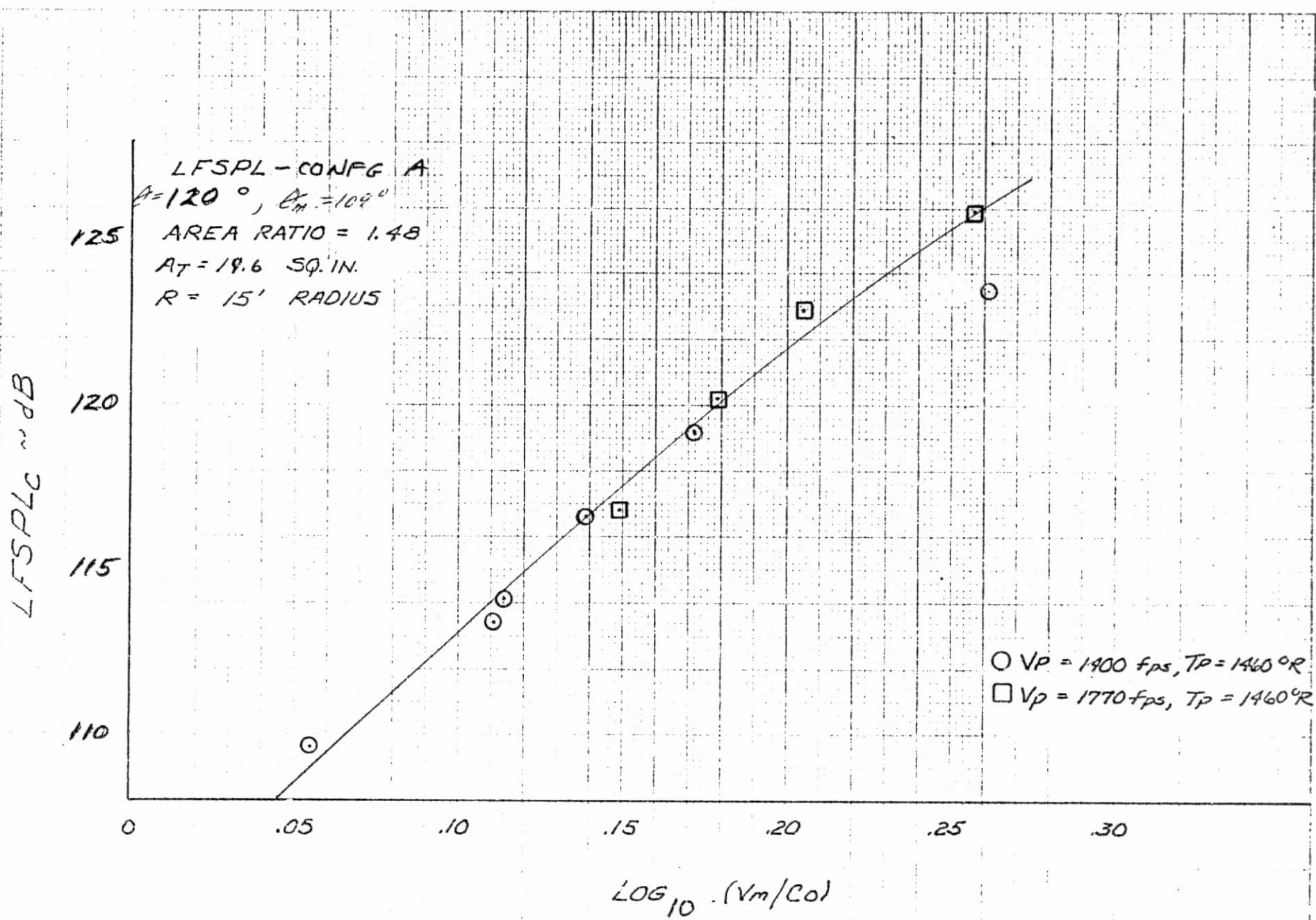
.30

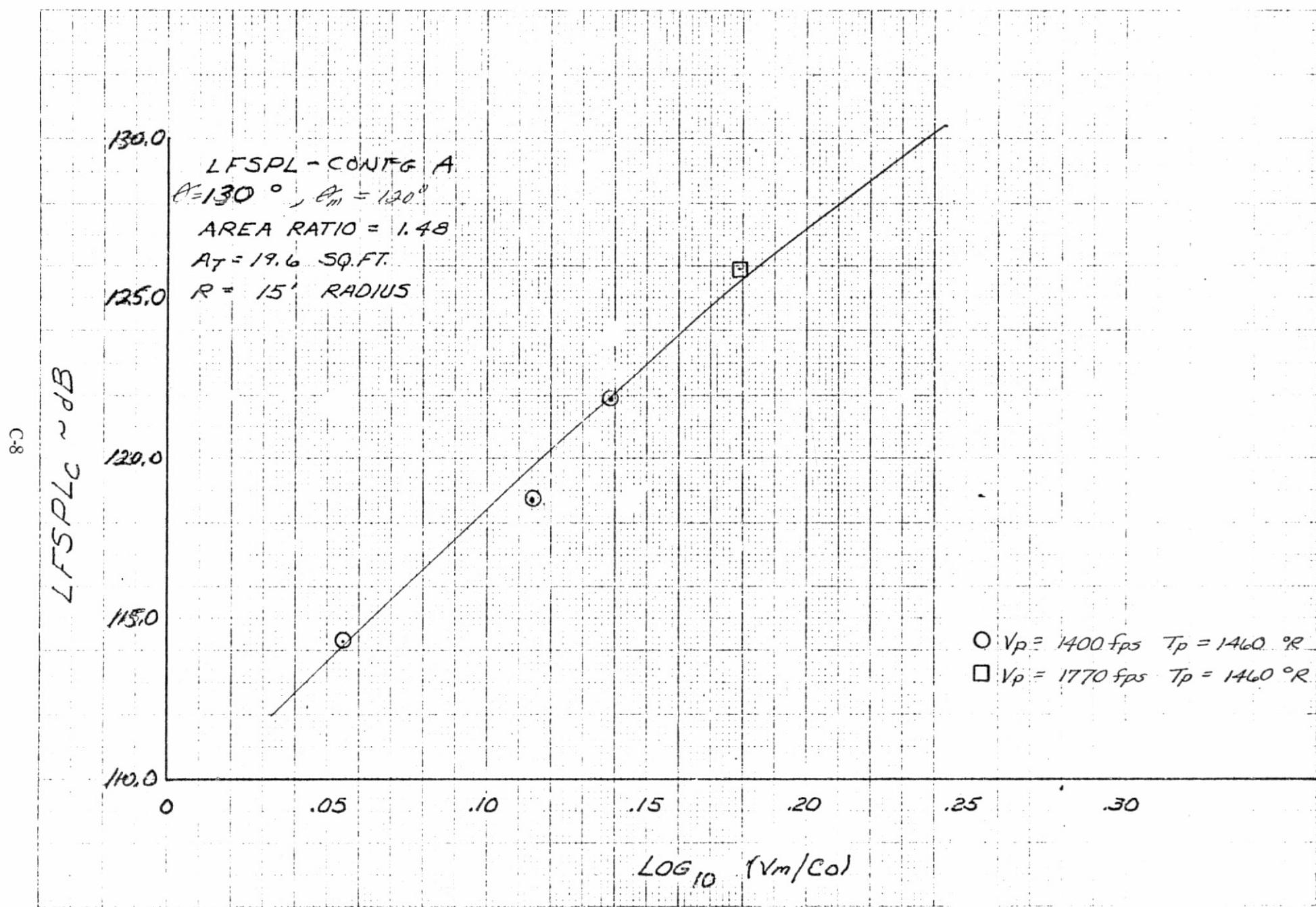
 $\log_{10}(V_m/C_0)$ $\circ V_p = 1400 \text{ f.p.s., } T_p = 1460^\circ R$ $\square V_p = 1770 \text{ f.p.s., } T_p = 1460^\circ R$ 











LFSPL - CONF A

 $\theta = 140^\circ, \theta_m = 132^\circ$

AREA RATIO = 1.48

 $A_T = 19.6$ SQ. IN. $R = 15'$ RADIUS $L_{FSPL} \sim dB$

135

130

125

120

0

.05

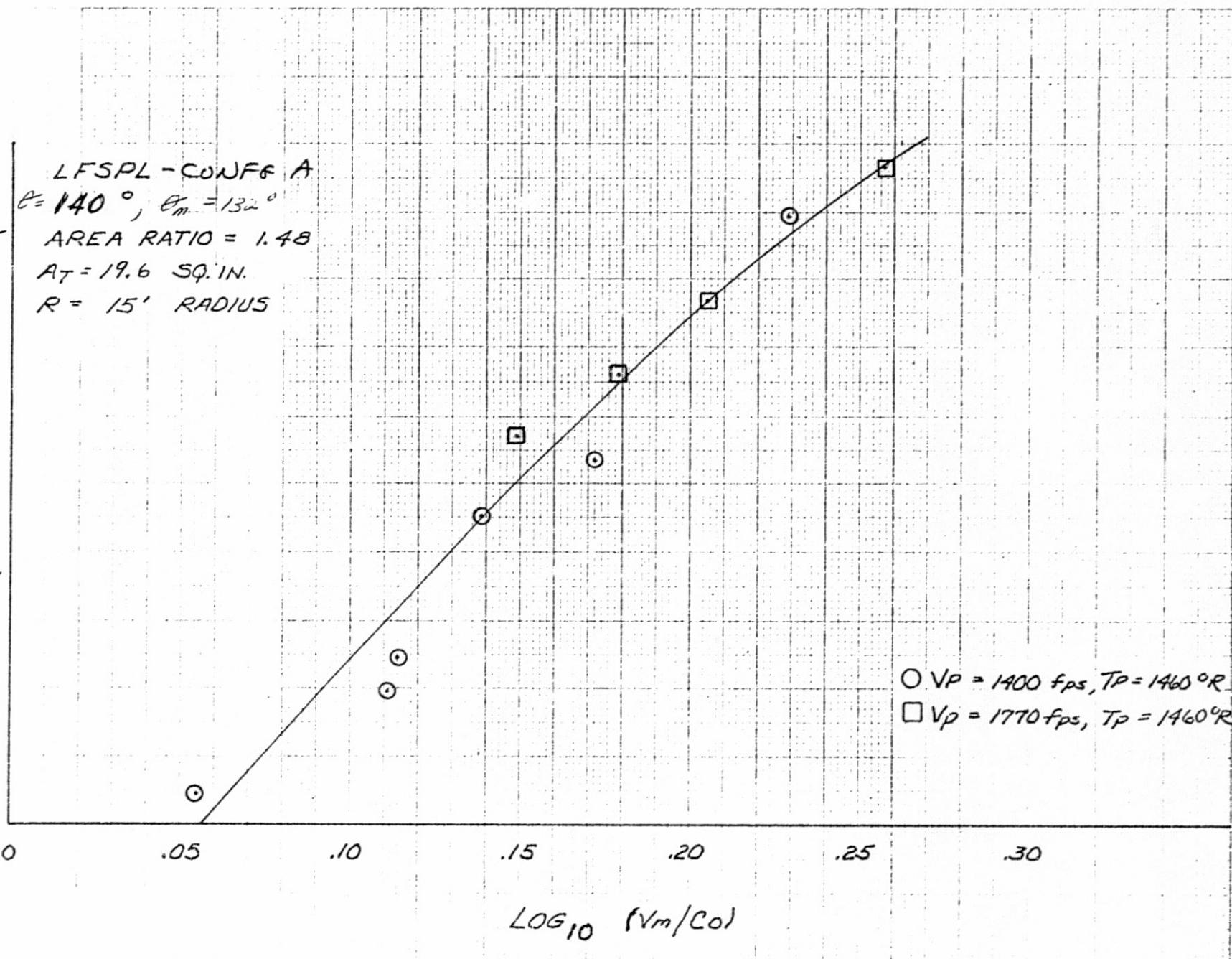
.10

.15

.20

.25

.30

 $\log_{10} (V_m/C_0)$ 

C-10

1400

LFSPL - CONF A

 $\theta = 150^\circ, \theta_m = 143^\circ$

AREA RATIO = 1.48

 $A_T = 19.6 \text{ SQ.FT.}$

1350

 $R = 15' \text{ RADIUS}$ $L_{FSPLC} \sim dB$

130.0

1250

120.0

0

.05

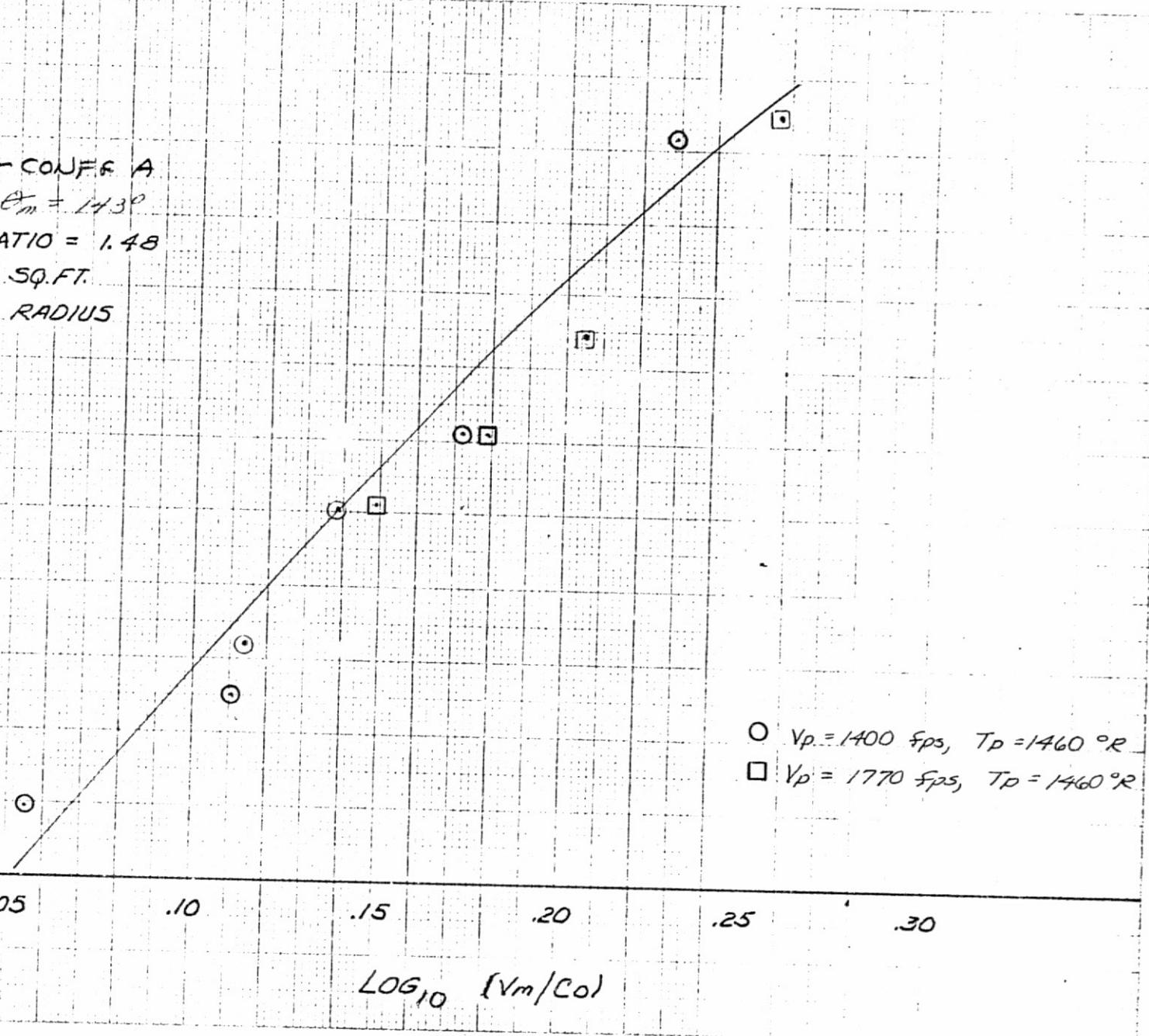
.10

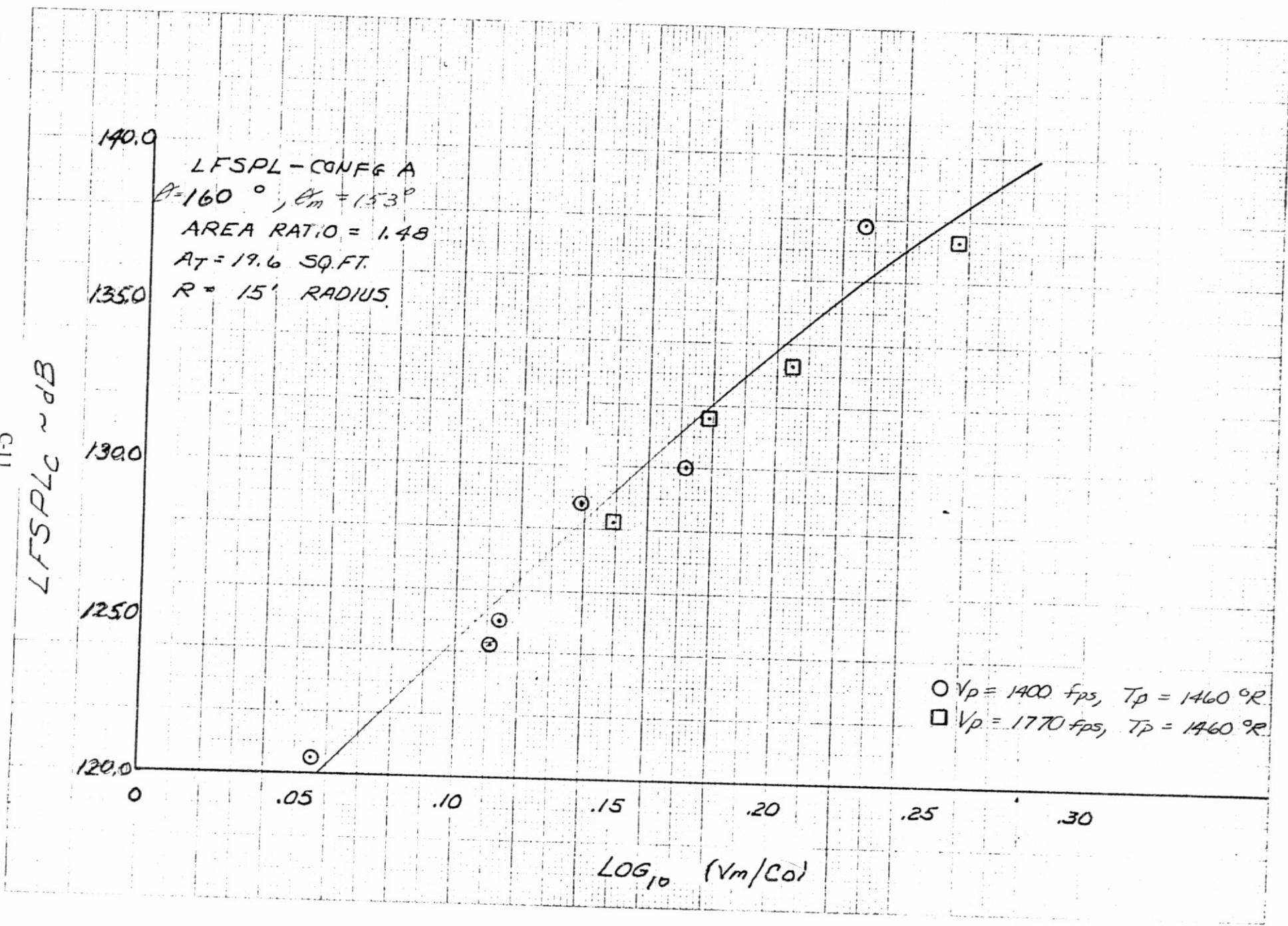
.15

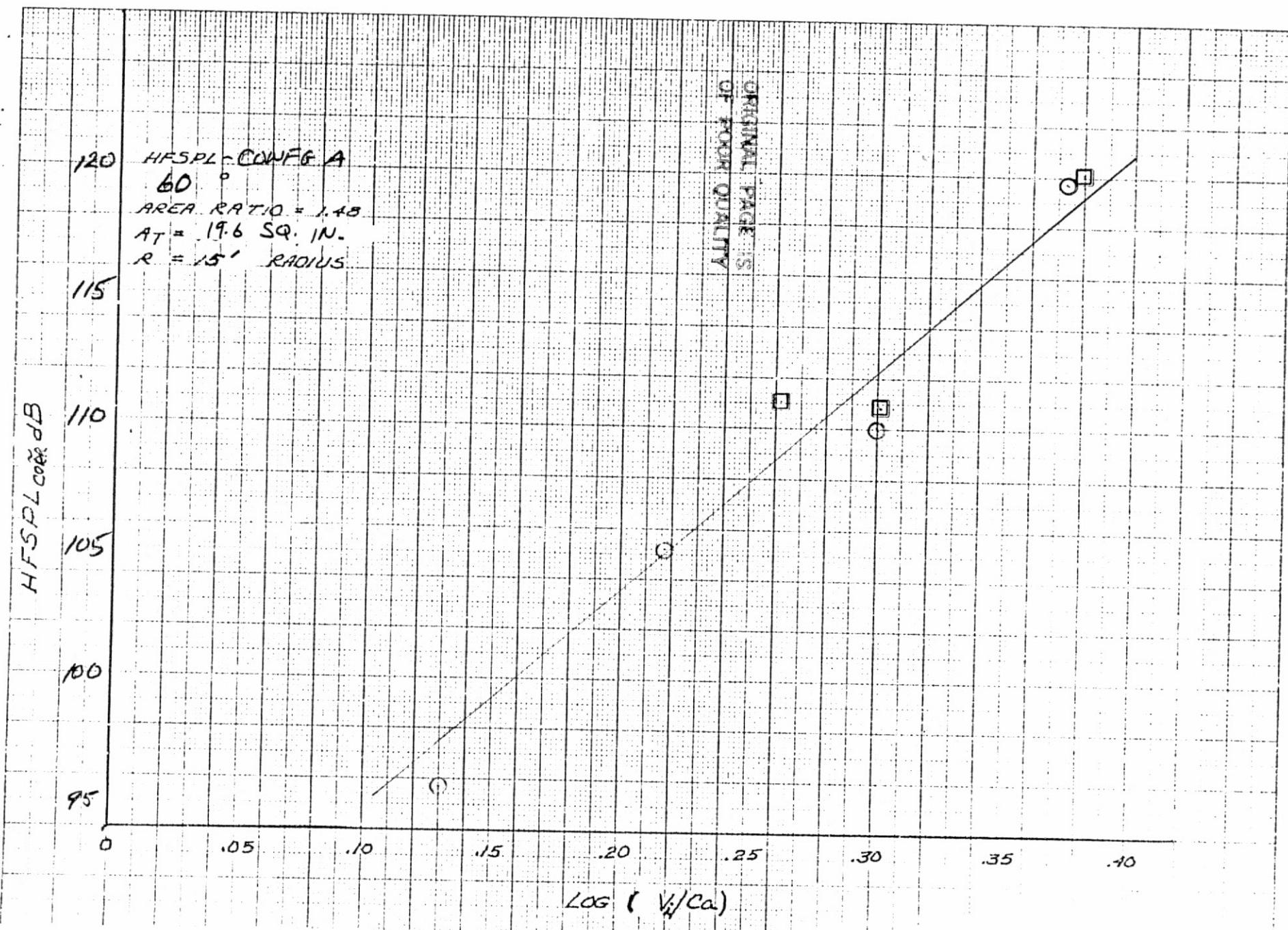
.20

.25

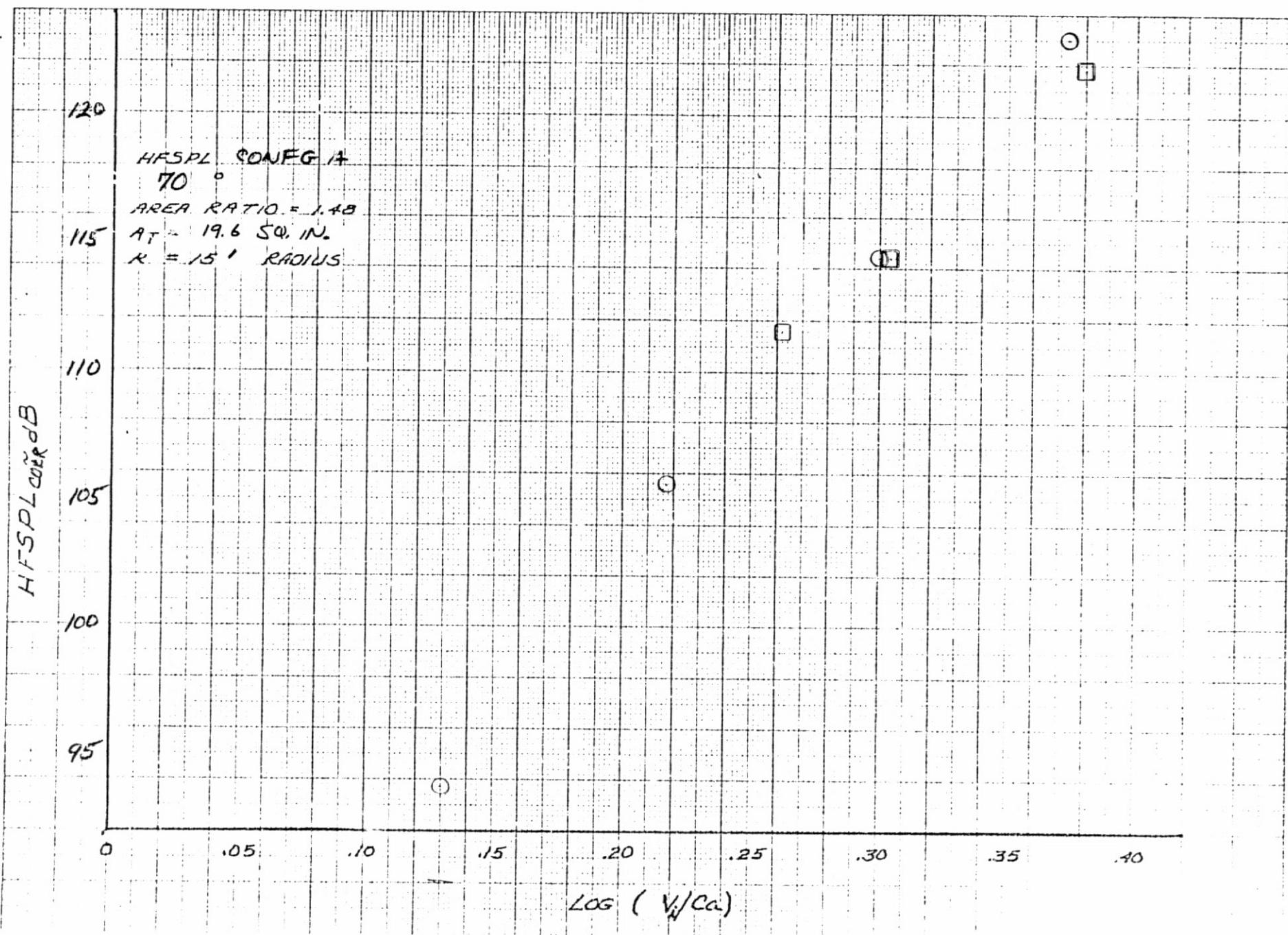
.30

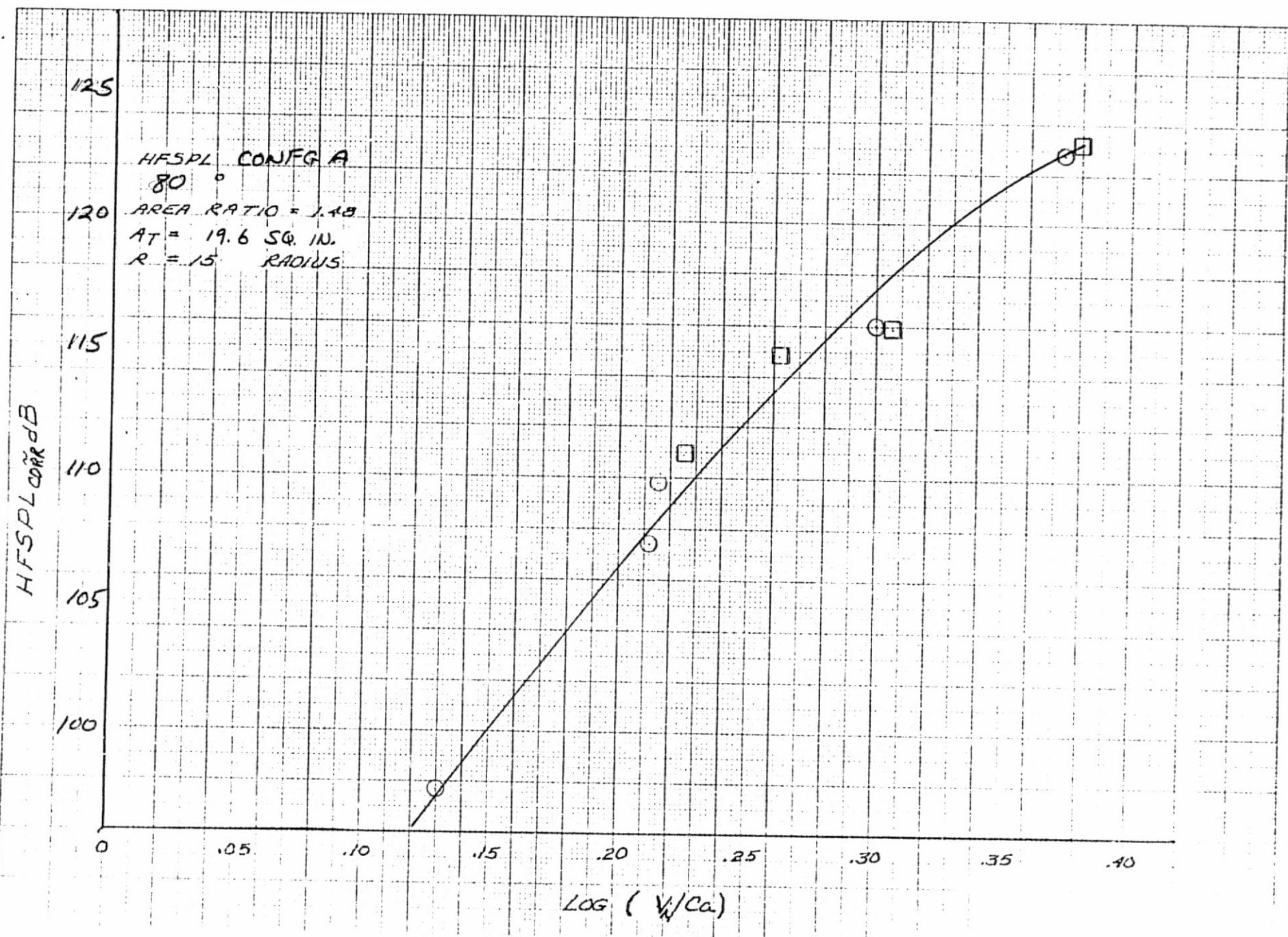
 $\log_{10} (V_m/C_0)$ 





C-13





130

125

120

115

C-15

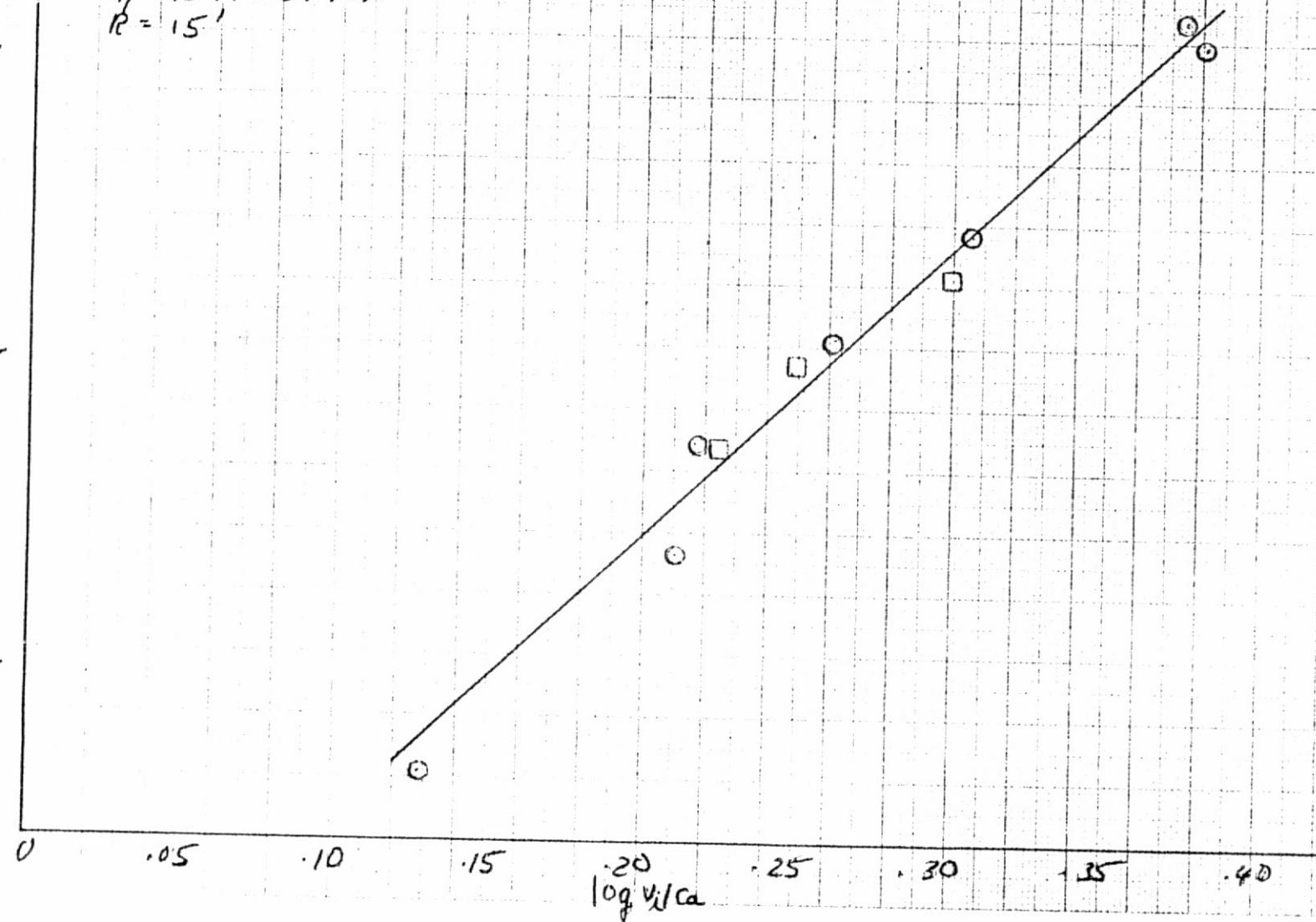
110

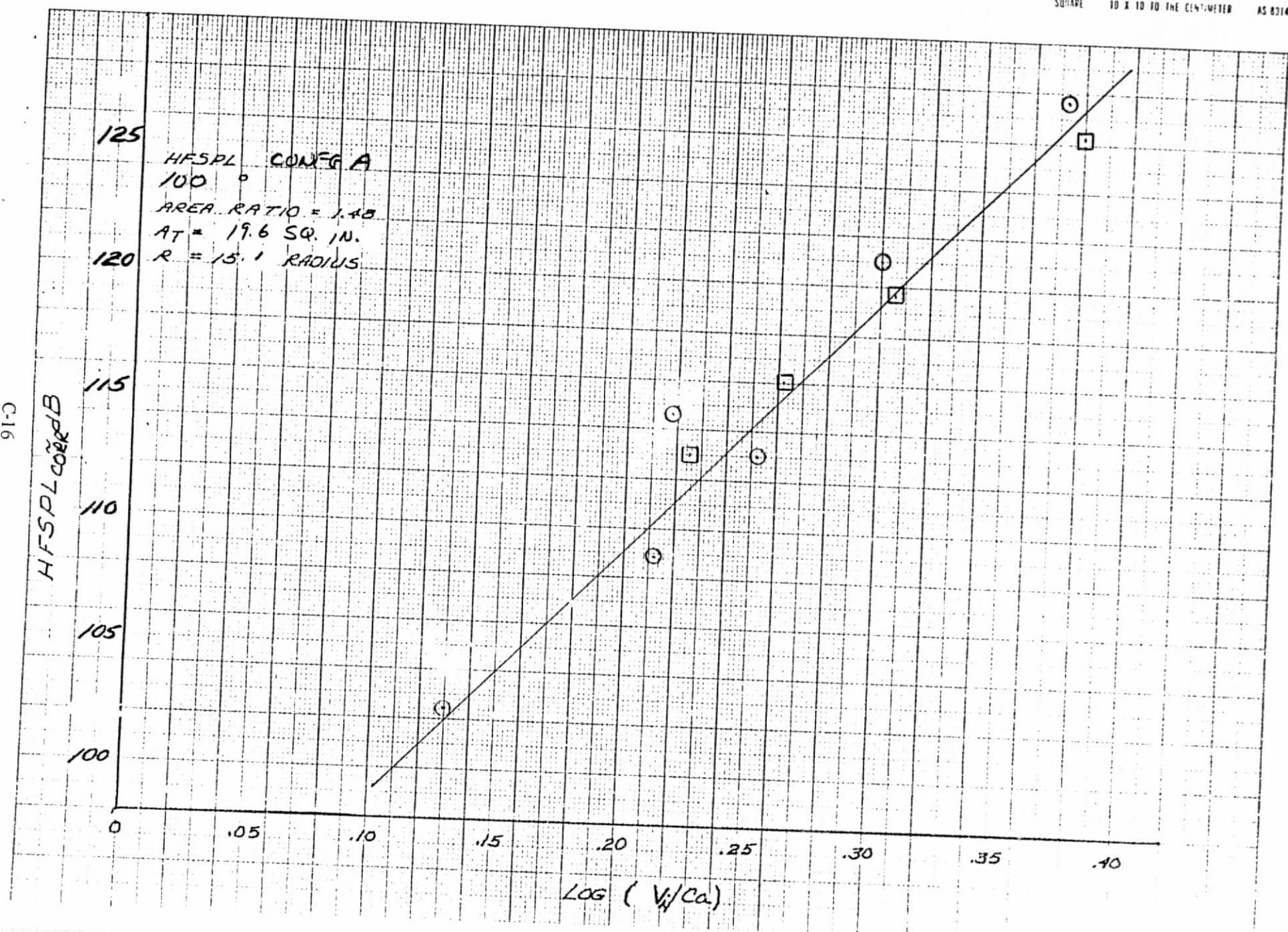
105

100

HFSPL
CONFIG A
 90°

AREA RATIO = 1.48
 $A_T = 19.6 \text{ SQ. IN.}$
 $R = 15'$





C-17

HFSPL - HFSPL_{core}

130
125
120
115
110
105
100

HFSPL - CONFIG A

110°

AREA $A_{T10} = 1.48$
 $A_T = 19.6 \text{ SQ. IN.}$
 $R = 15'$

.05 .10 .15 .20 .25 .30 .35 .40

$\log V_t/V_{t0}$

(1)

(2)

(3)

(4)

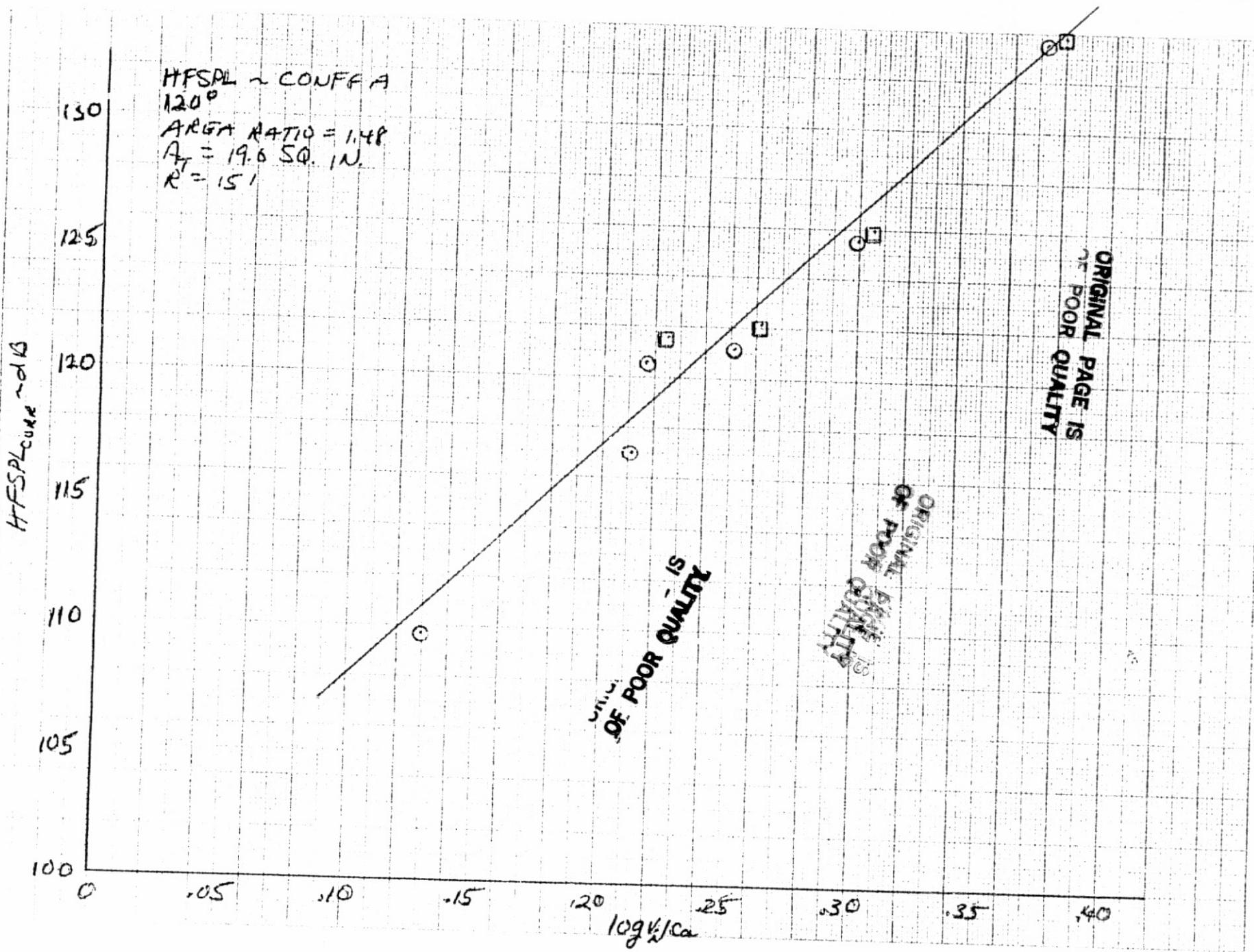
(5)

(6)

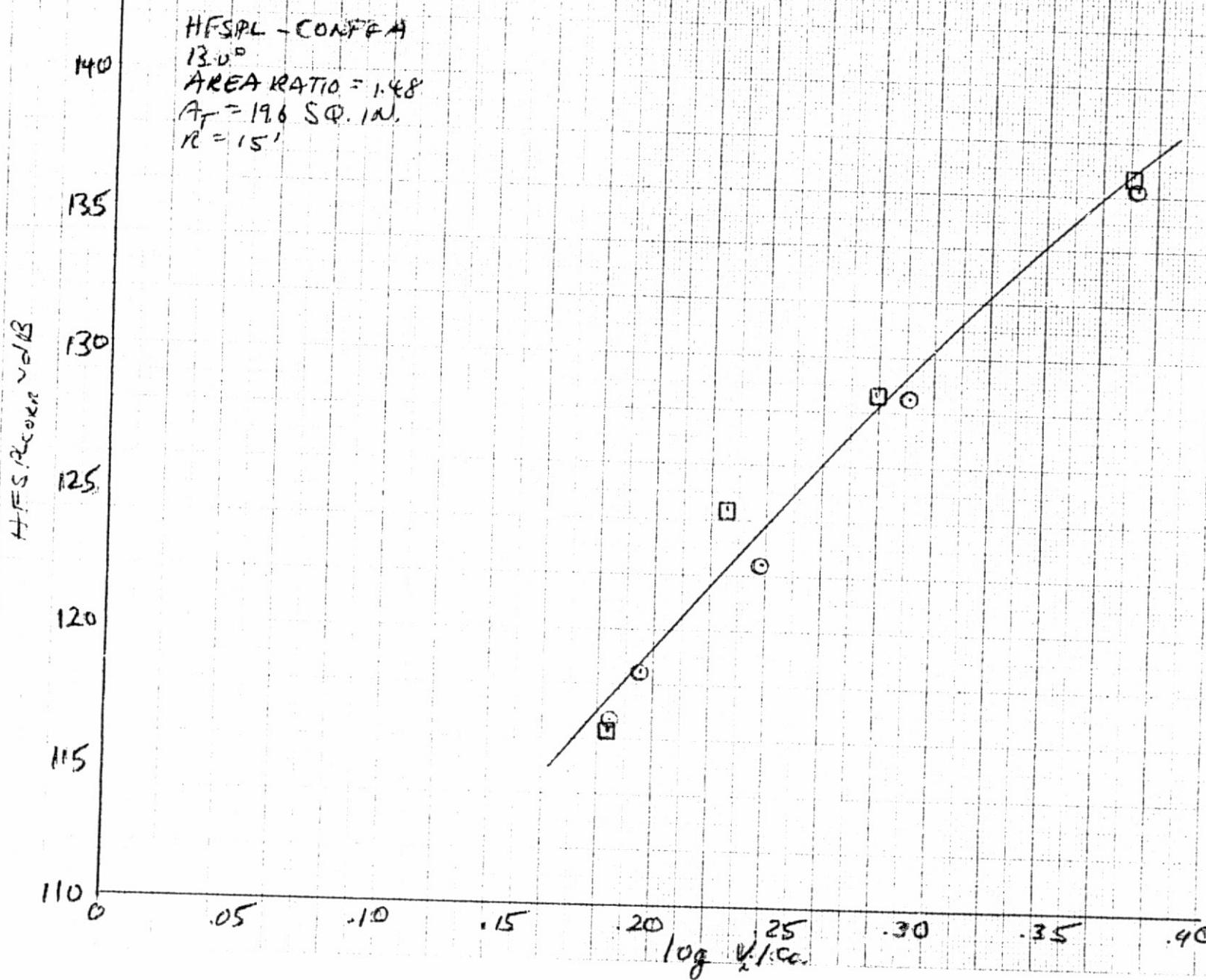
(7)

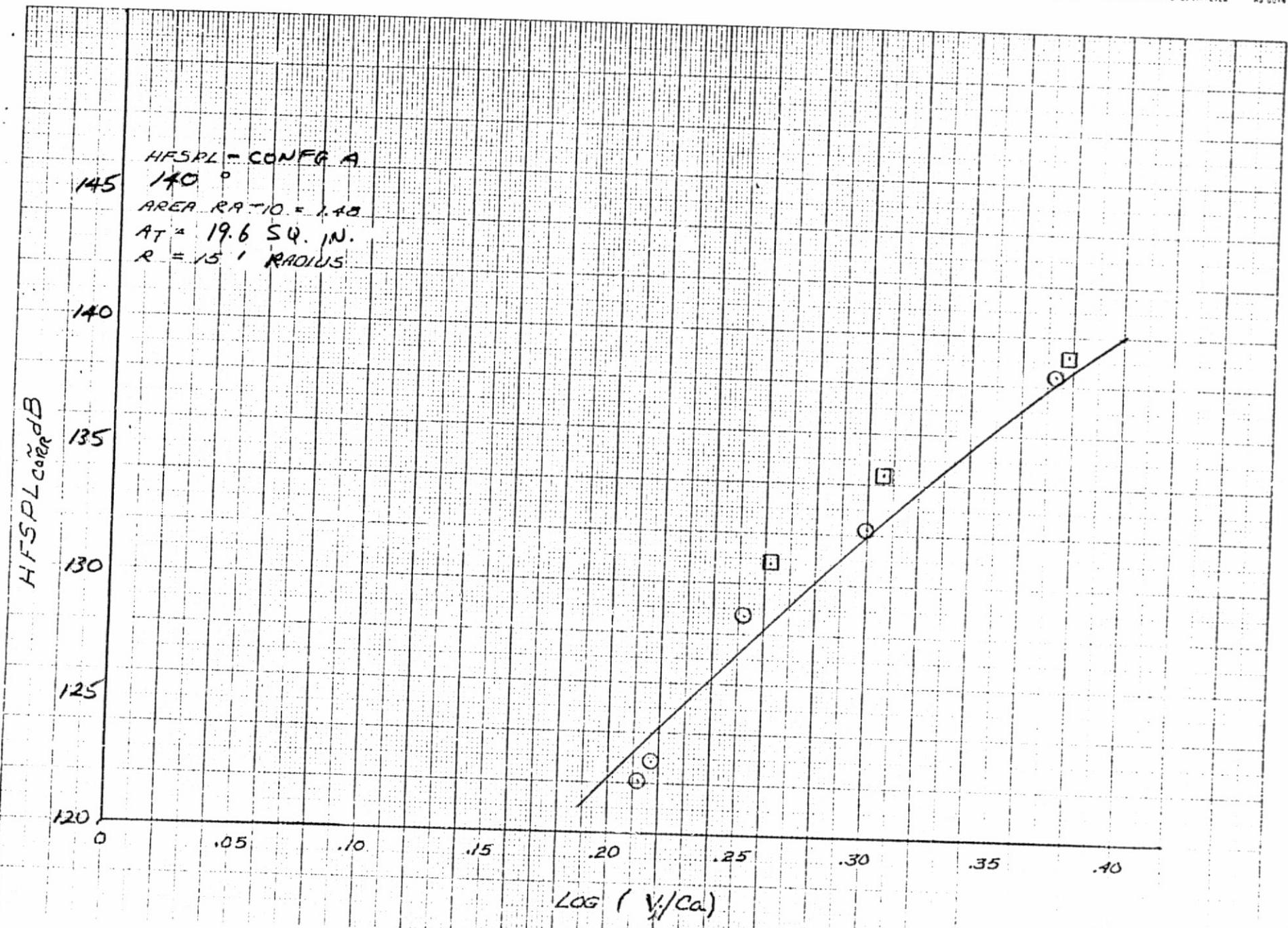
(8)

C-18



C-19





140
135
130
125
120
115
110

C-21

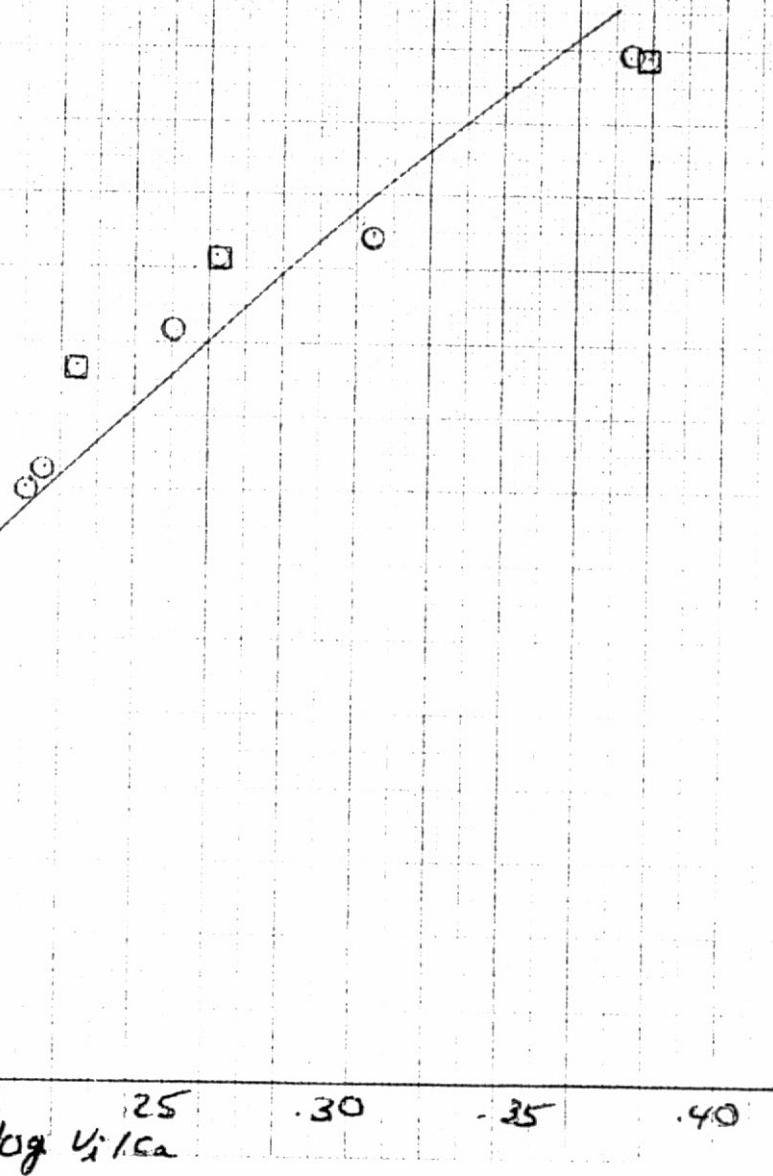
SP ~ SPLcorr - SPLSPLH

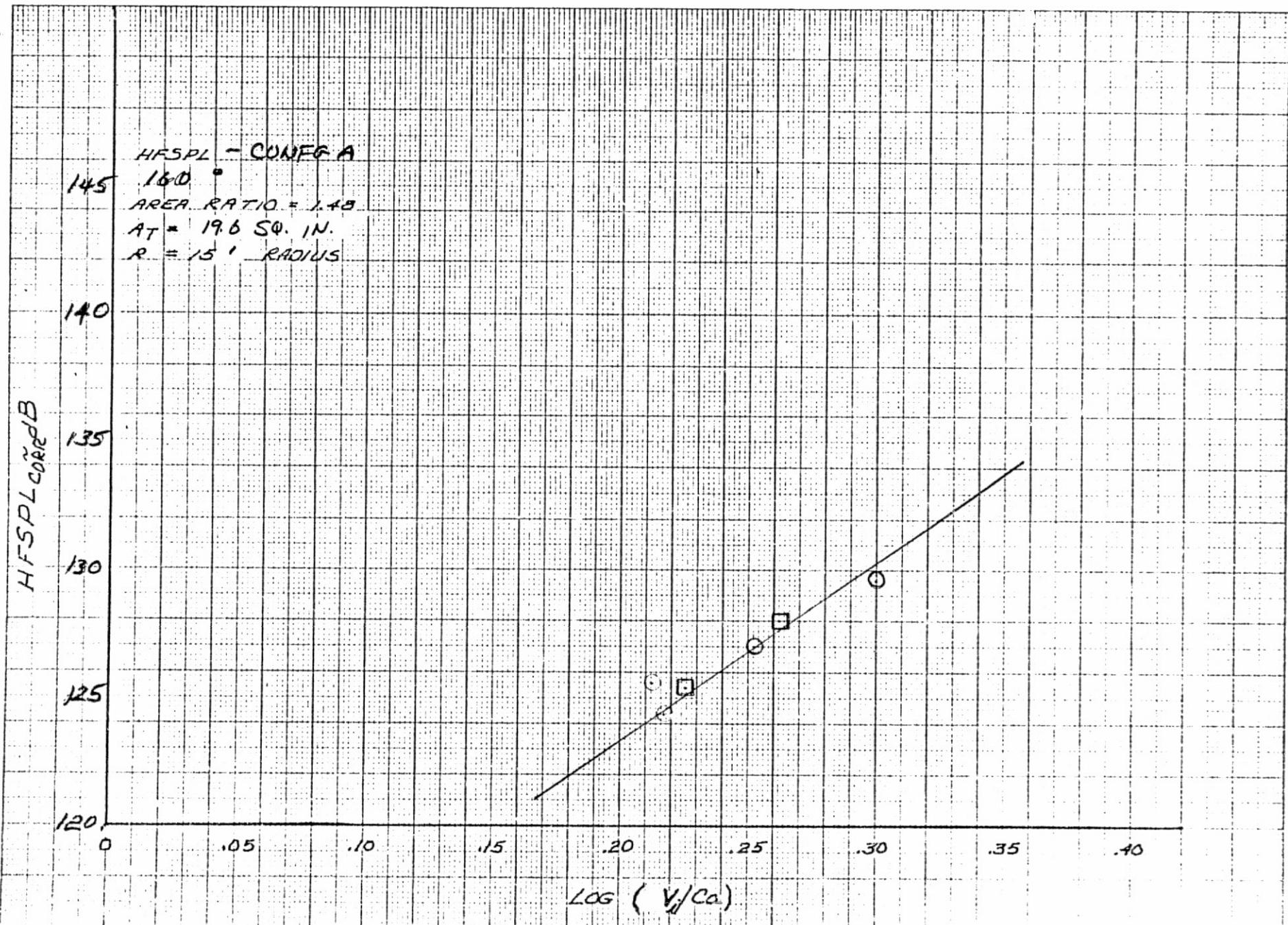
HFSPL - CONF A
150°
AREA RATIO = 1.48
 $A = 19.6 \text{ sq. in.}$
 $R = 15'$

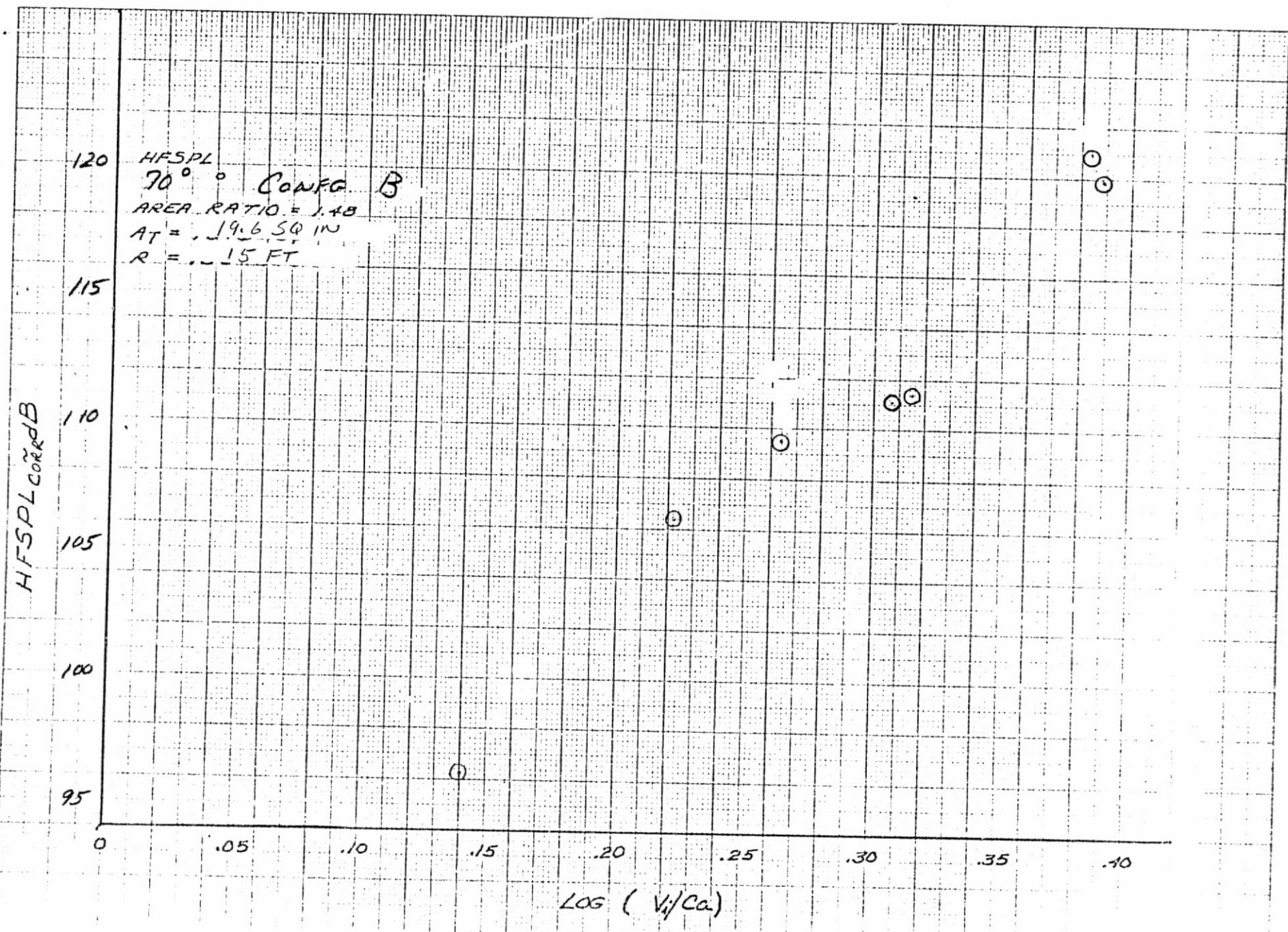
.05 .10 .15 .20 .25 .30 .35 .40

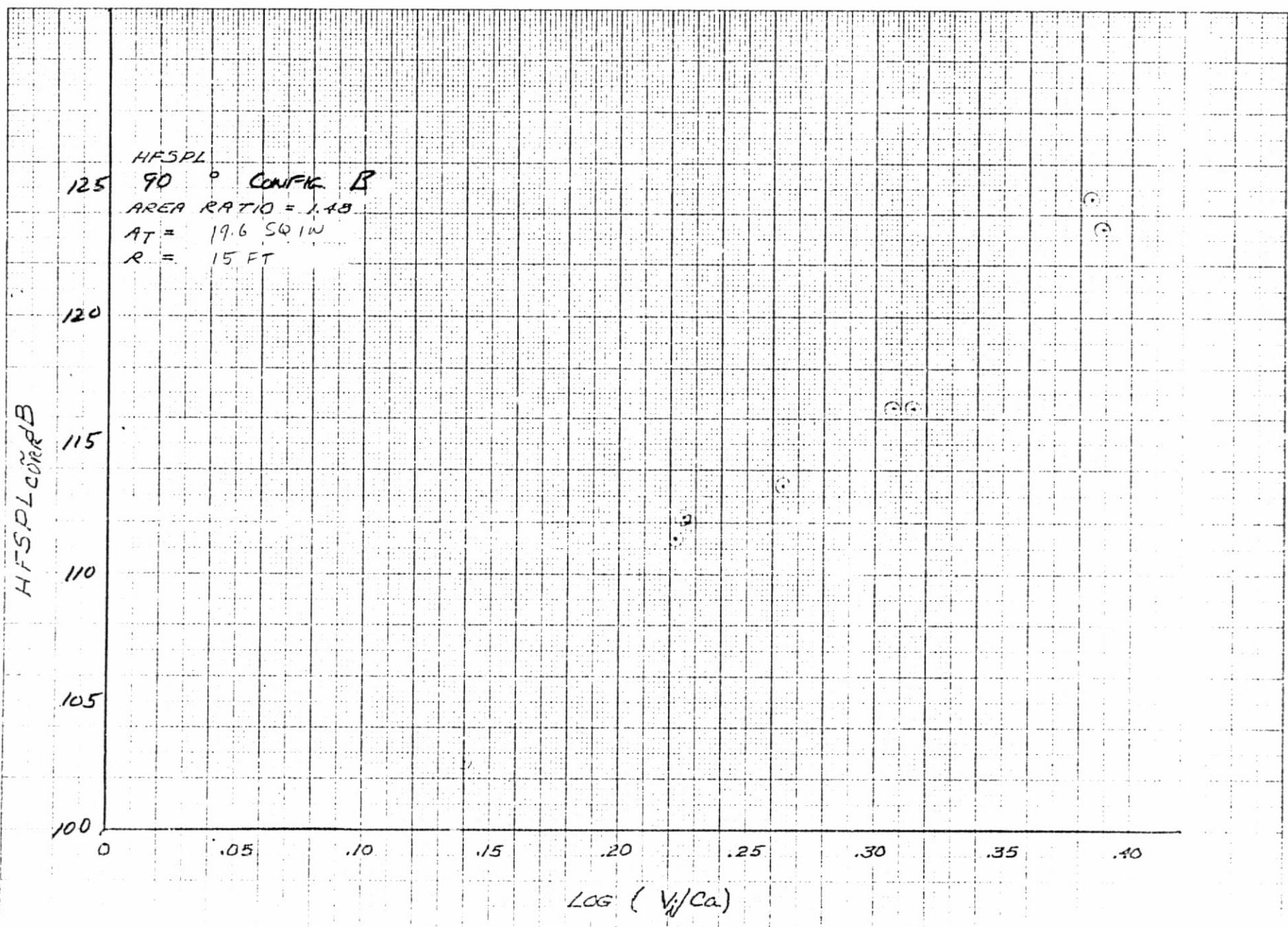
$\log U_1/U_{\infty}$

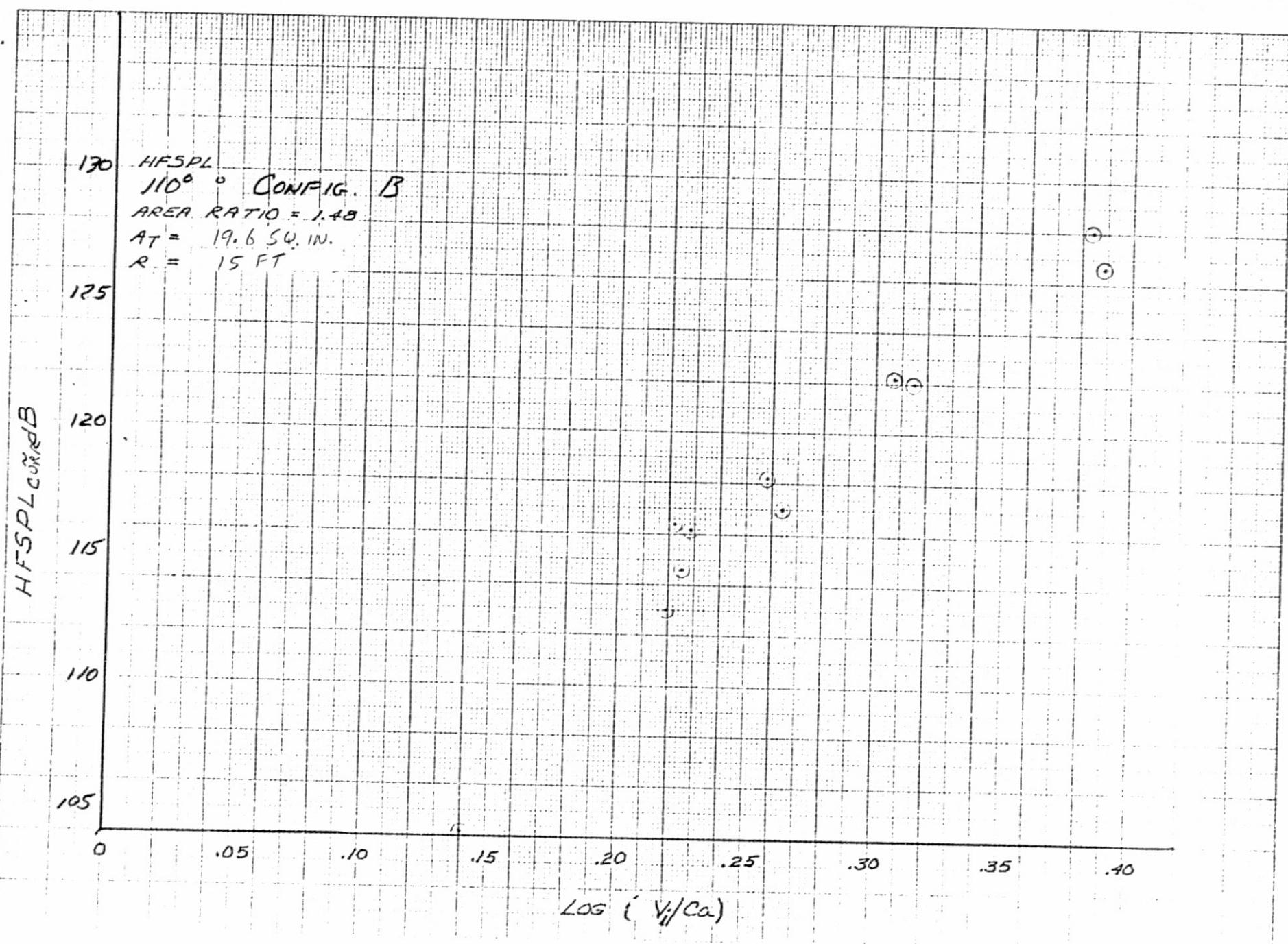
(○)











ORIGINAL
OF POOR PAGE IS
POOR QUALITY

HF SPL
130° ° Config. B
AREA RATIO = 1.48
 $A_T = 19.650 \text{ IN}$
 $R = 15 \text{ FT}$

125

120

115

110

105

0

.05

.10

.15

.20

.25

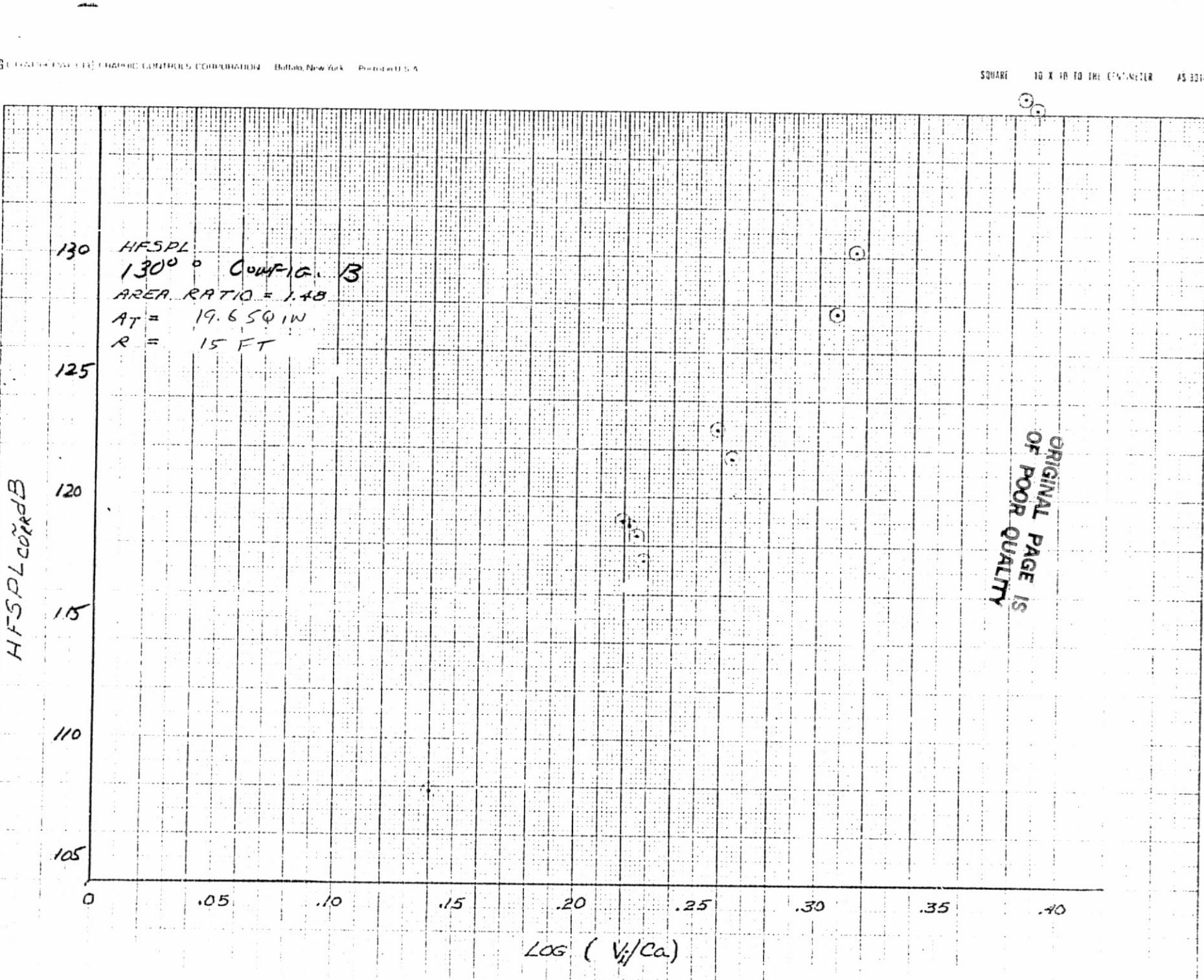
.30

.35

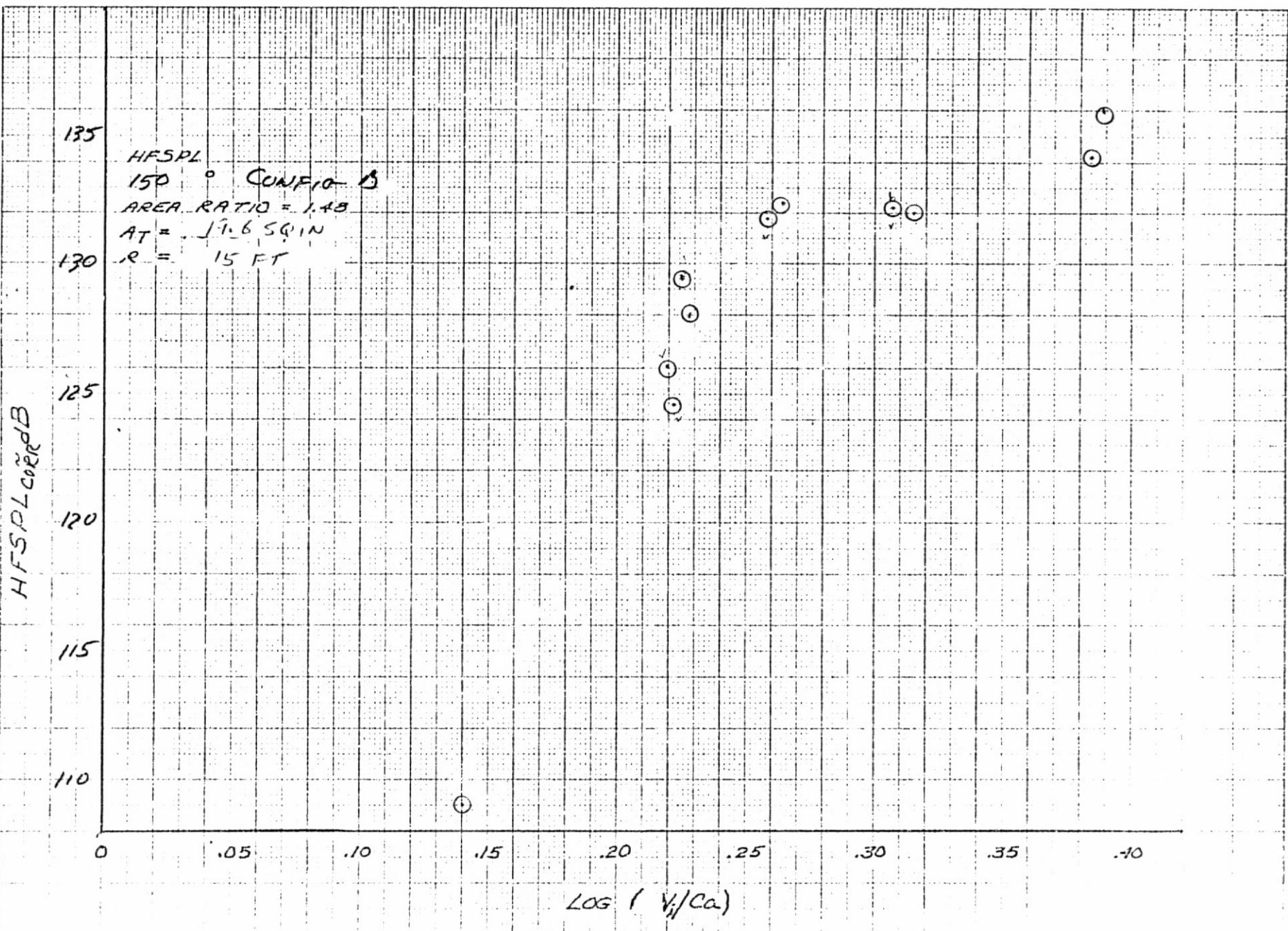
.40

$\log (V_i/C_a)$

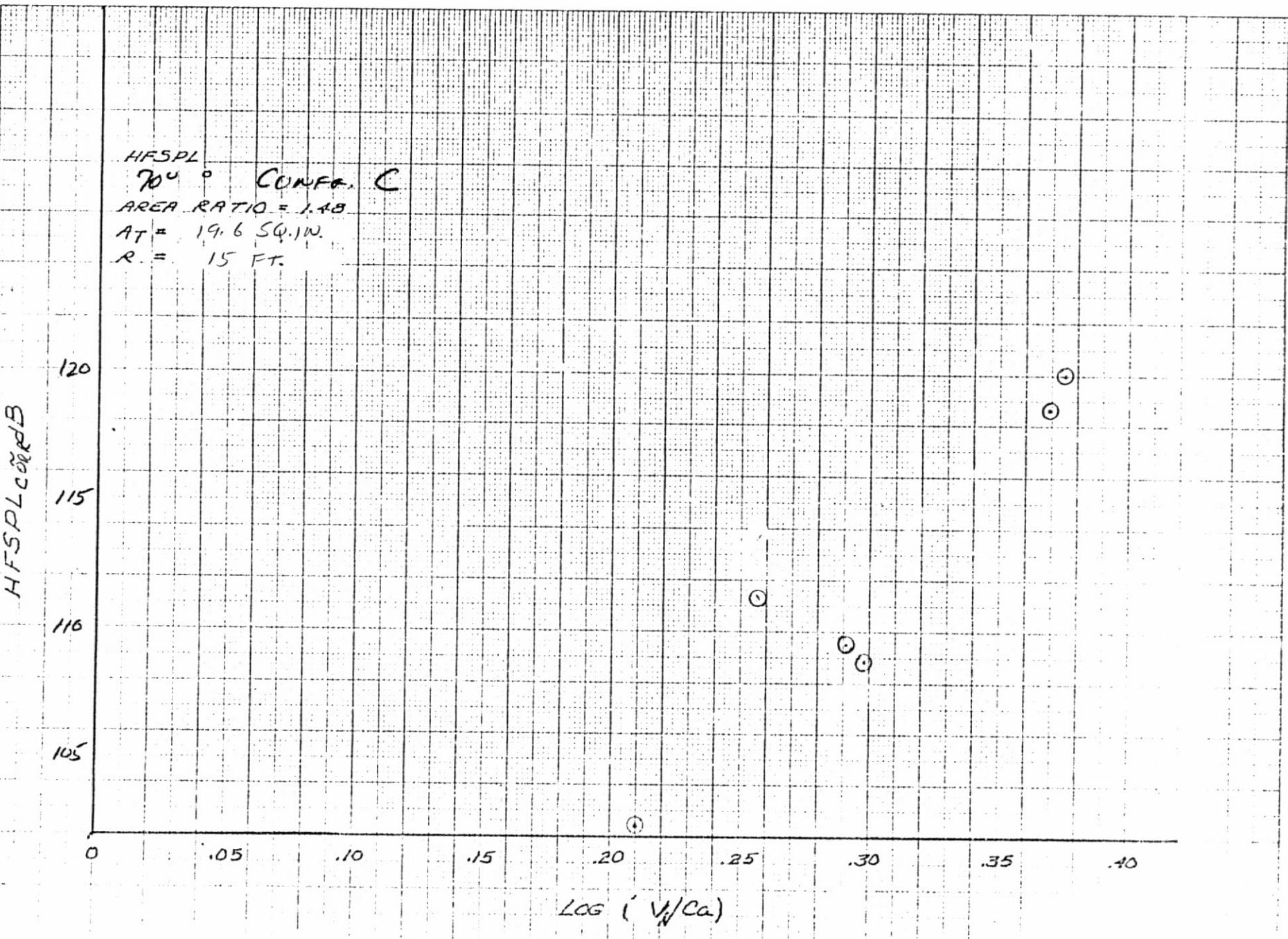
C-26



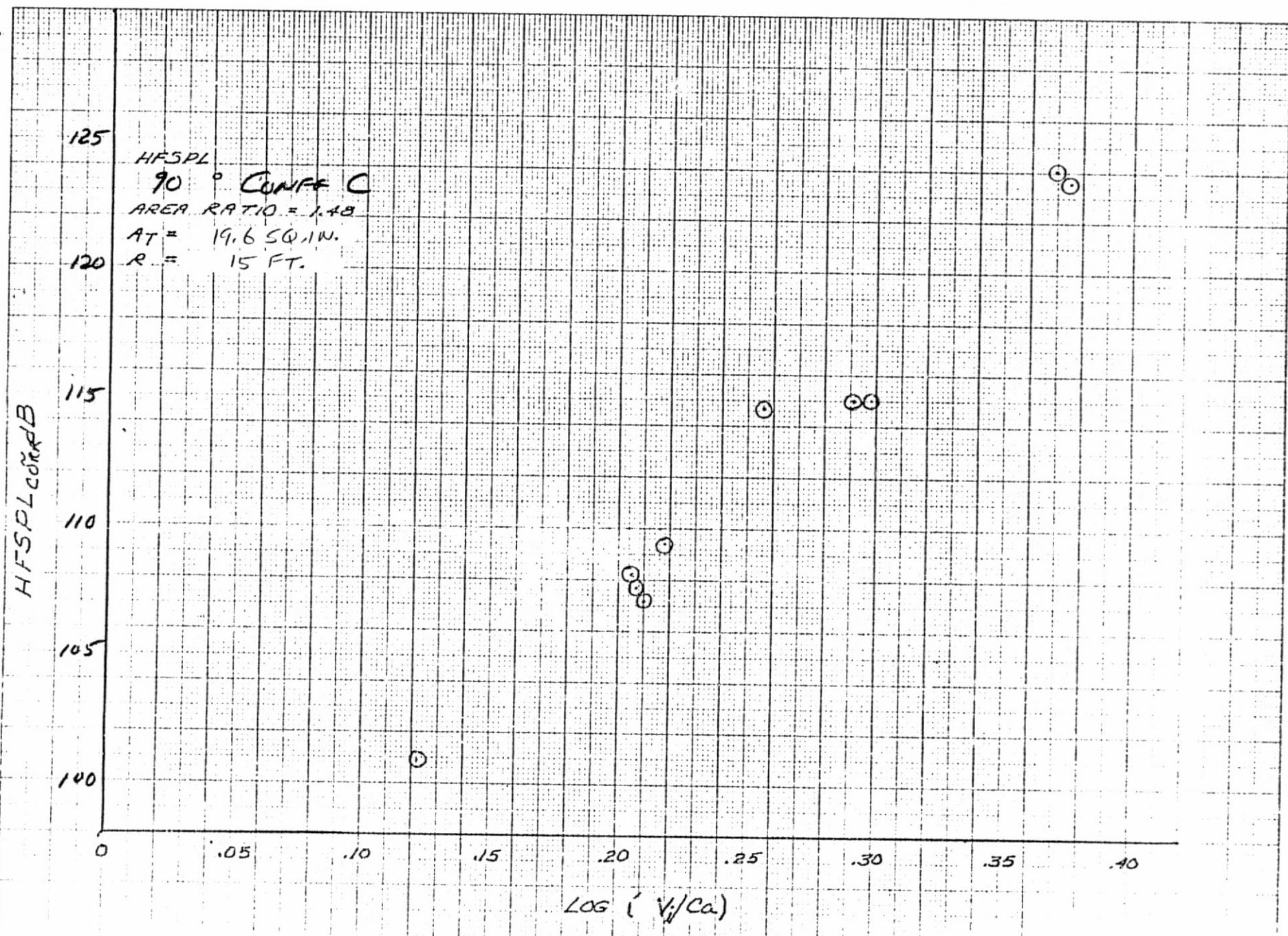
C-27



HFSPL
70° ° CONF. C
AREA RATIO = 1.48
 $A_T = 19.6 \text{ SQ. IN.}$
 $R = 15 \text{ FT.}$



C-29



130

125

120

115

110

105

100

0

HFSPL
110° CONFIG. C

AREA RATIO = 1.48

AT = 19.650 IN.

R = 15 FT.

HFSPL LOG₁₀B

.05 .10 .15 .20 .25 .30 .35 .40

LOG (V/V₀)

130 HFSP1
130 ° CONFIG. C.
AREA RATIO = 1.40
AT = 19.6 SW. W.
R = 15 FT.

125

120

115

110

105

HFSP1 LOG P/B

C-31

0 .05 .10 .15 .20 .25 .30 .35 .40

LOG ' V_i/C_a)

HFSPL

145 150° CONFG. C
AREA RATIO = 1.43
 $A_T = 19.6 \text{ SG, IR}$,
 $R = 15 \text{ F.T.}$

140

135

130

125

120

HFSPL CORRDB

0 .05 .10 .15 .20 .25 .30 .35 .40

$\log (V_f/C_a)$

30

125

HFSPL
70° ° CURVE. D
AREA RATIO = 1.48
 $A_T = 19.6 \text{ SQ. IN.}$
 $R = 15 \text{ FT.}$

120

115

110

105

100

95

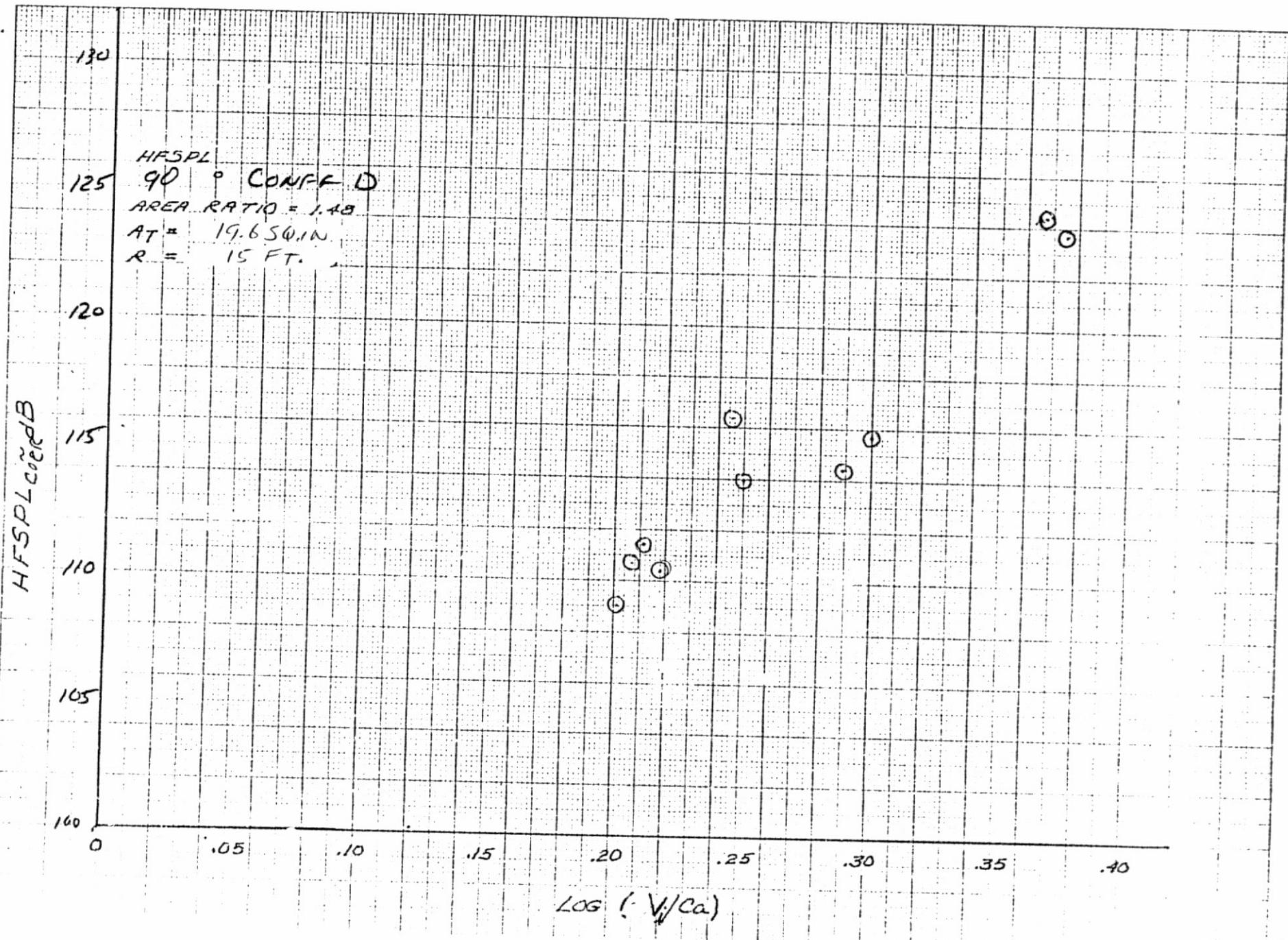
HFSPL CORDED

0 .05 .10 .15 .20 .25 .30 .35 .40

LOG. (V_f/C_a)

C-33

C-34



130
110 ° CONFIG D
AREA RATIO = 1.49
 $A_T = 19.6 \text{ SQ. IN.}$
 $R = 15 \text{ FT.}$

125

120

115

110

105

0

.05

.10

.15

.20

.25

.30

.35

.40

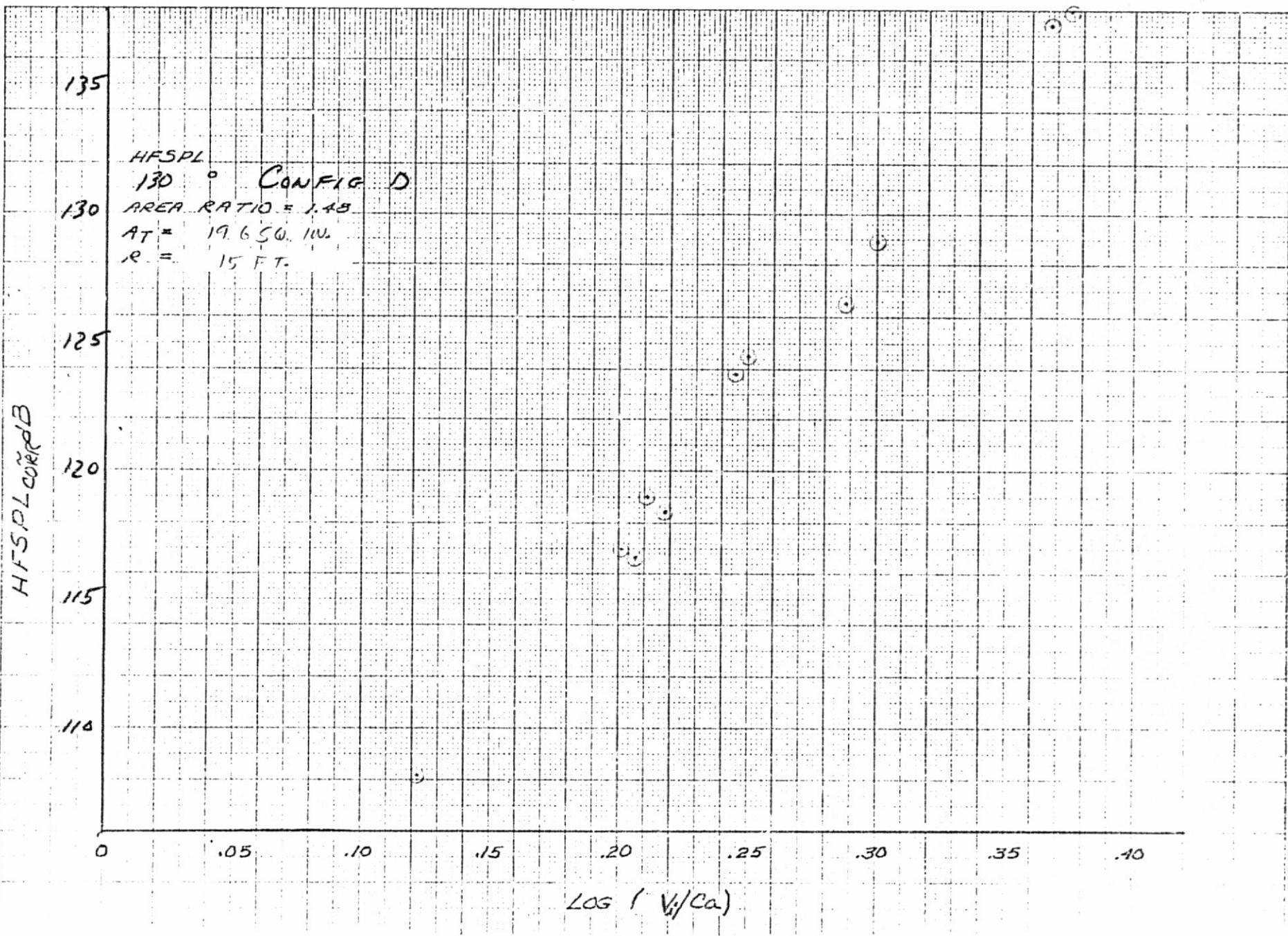
$\log (V/C_a)$

ORIGINAL PAGE IS
OF POOR QUALITY

8722007051H

C-35

C-36



HFSPL
145 150 ° CONFIG D
AREA RATIO = 1.48
 $A_T = 19.6 \text{ SQ. IN.}$
 $R = 15 \text{ FT.}$

140

135

130

125

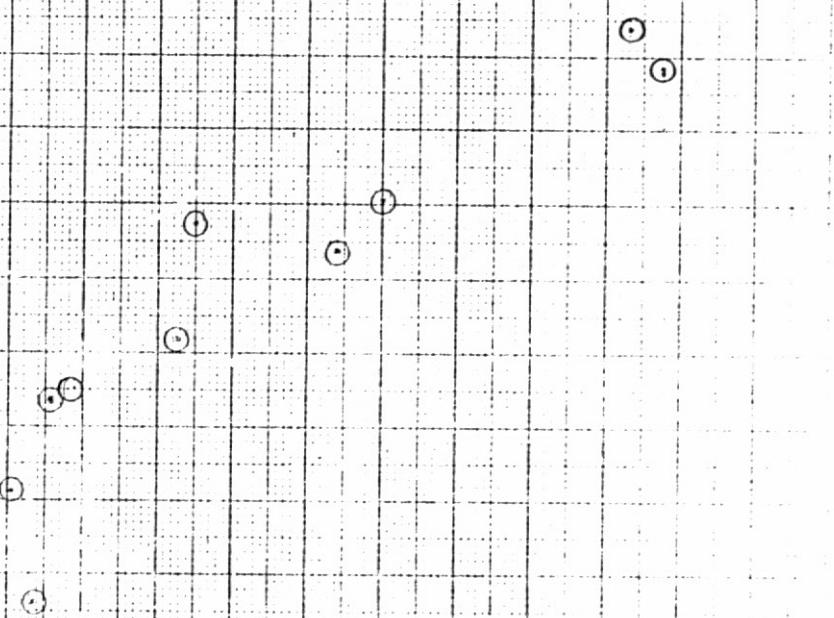
120

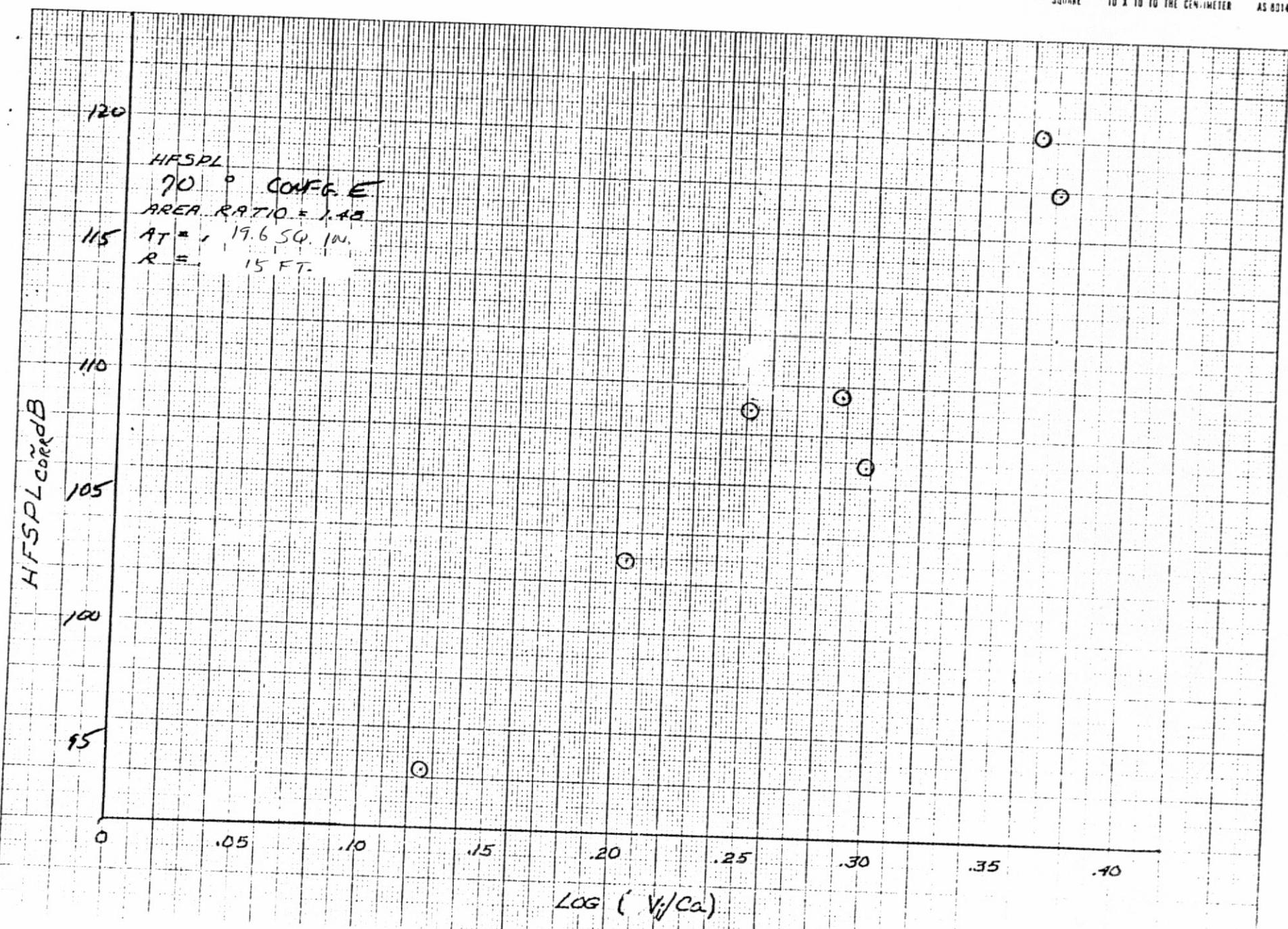
HFSPL CORR DB

C-37

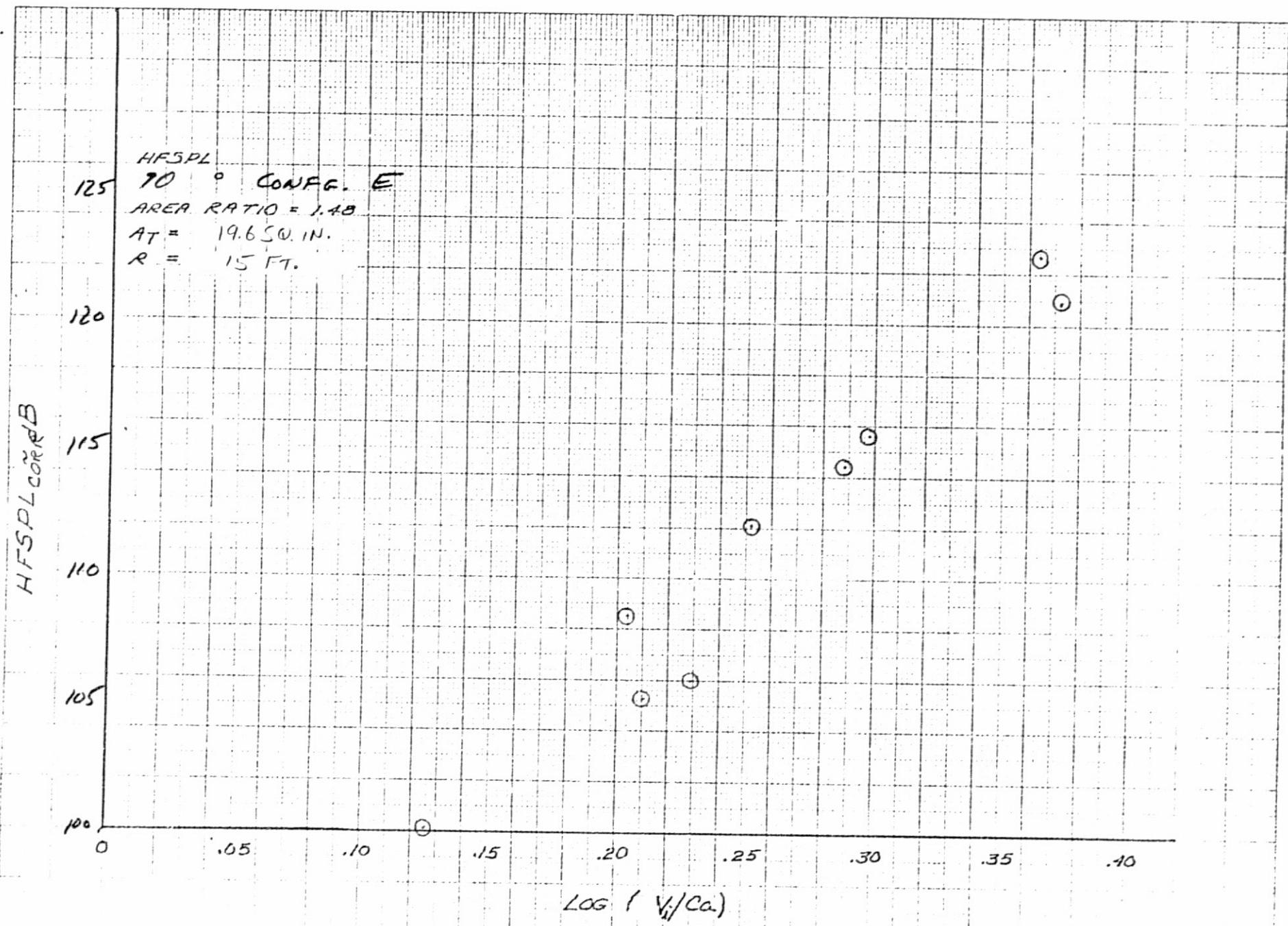
0 .05 .10 .15 .20 .25 .30 .35 .40

$\log (V_f/C_a)$





C-39



140

HFSPL

135 110° CONFIG E
AREA RATIO = 1.48
 $A_T = 19.654 \text{ in.}$
 $R = 15 \text{ FT.}$

130

125

C40

120

HFSPL COR/B

115

110

0

.05

.10

.15

.20

.25

.30

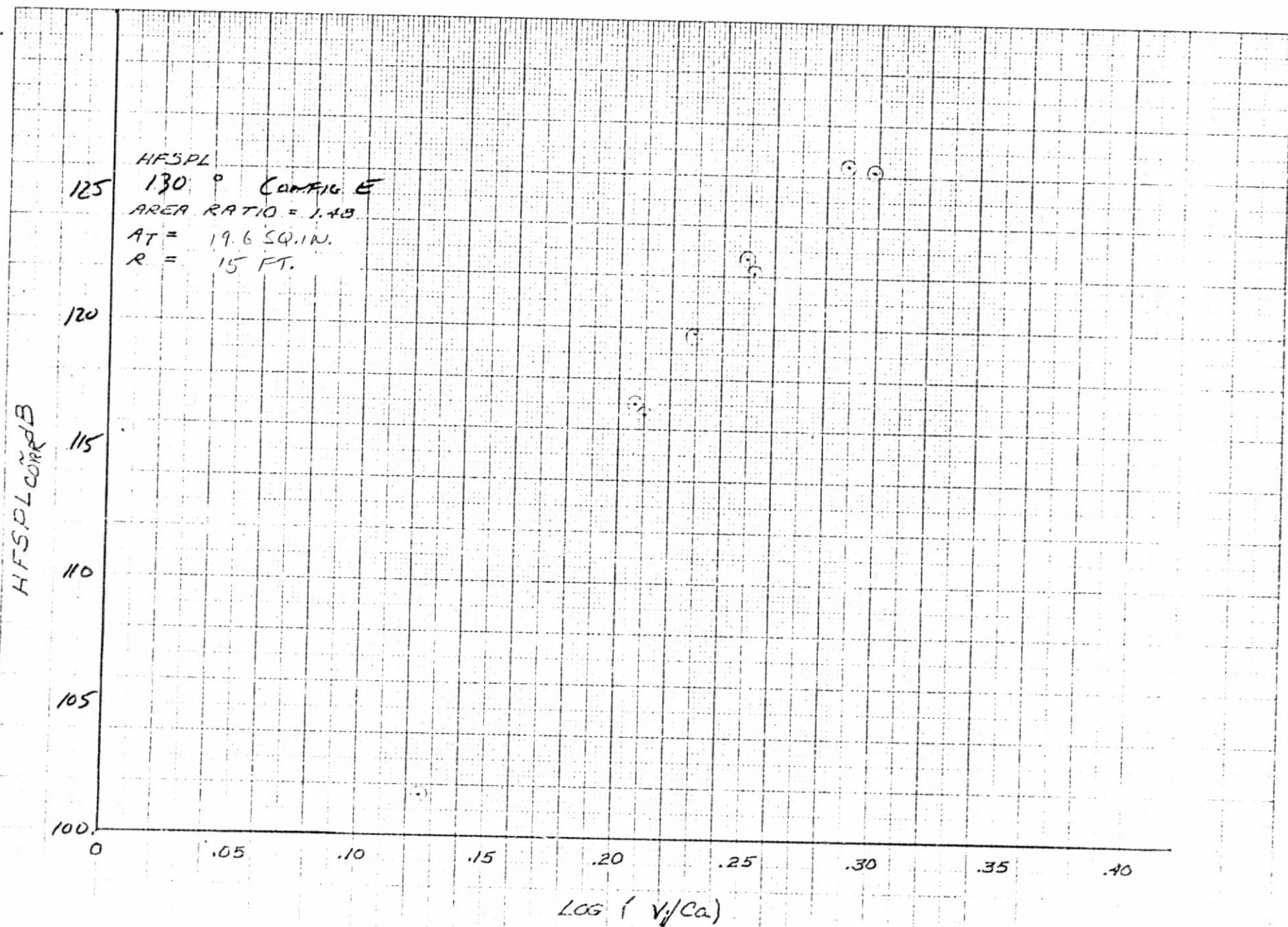
.35

.40

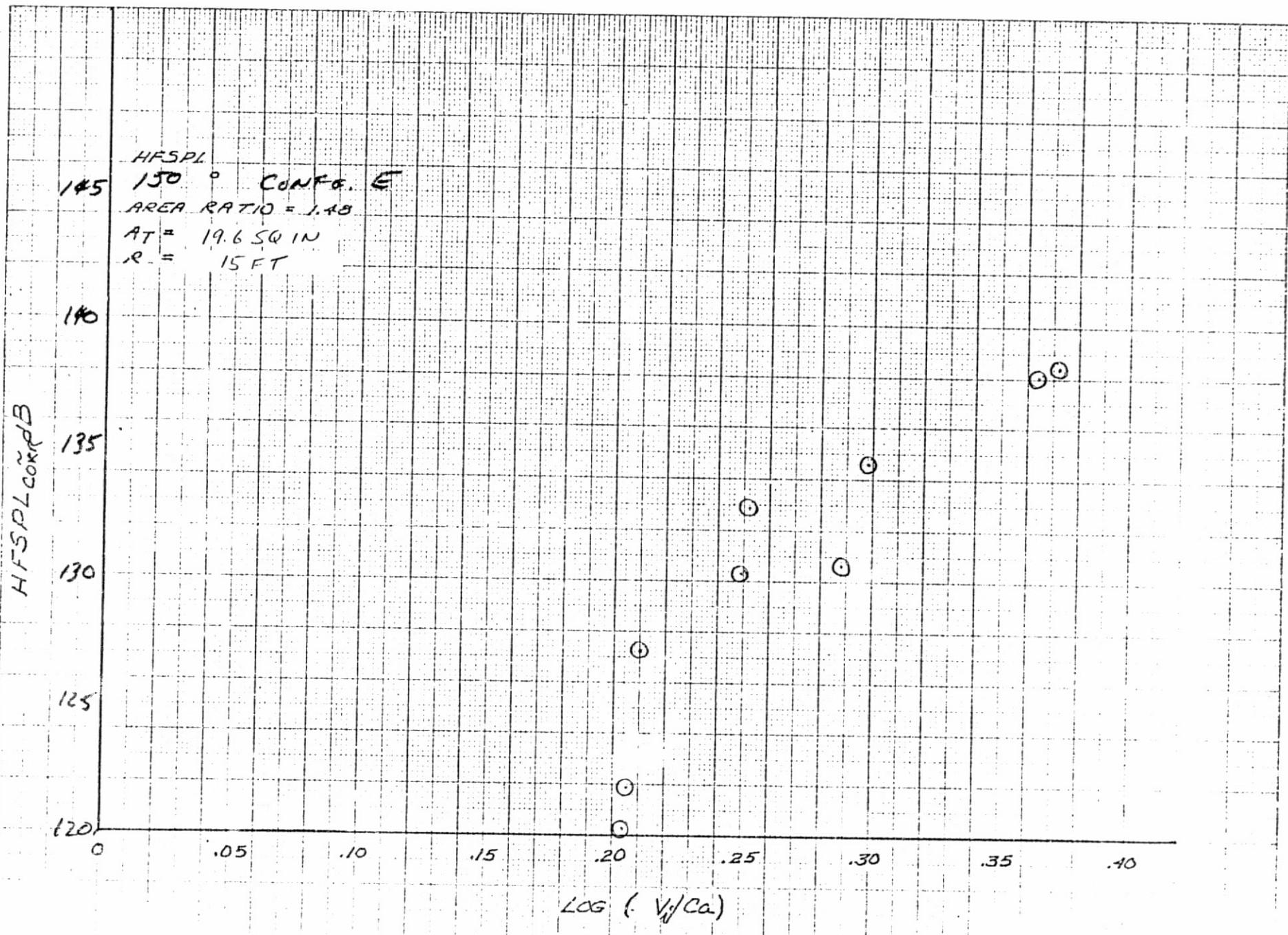
$\log (\alpha V_i/C_a)$

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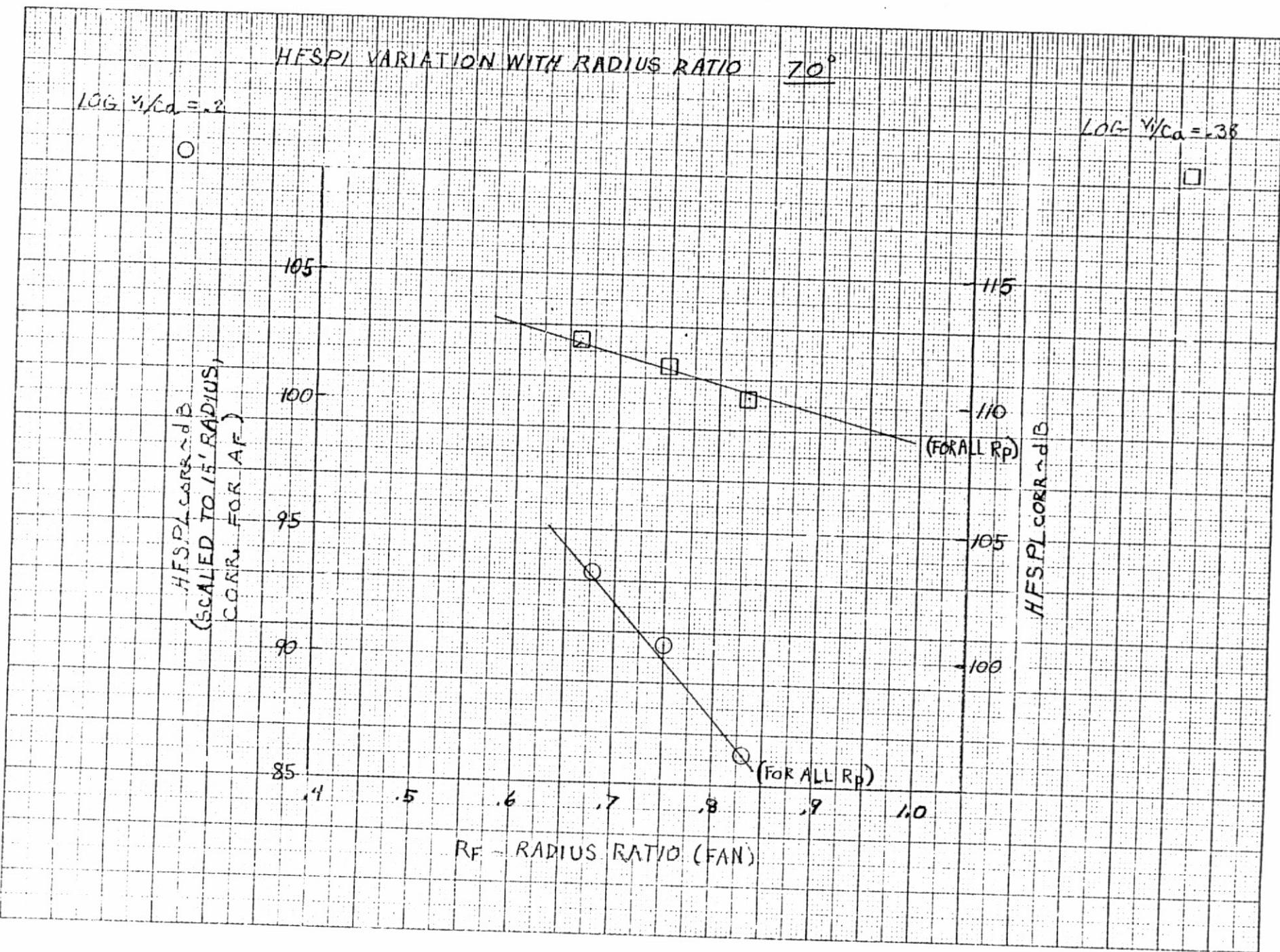
C41



C-42



C43



$\log V/c_a = .2$

0

105

90°

100

95

90

85

$H = 5.14 C$
(SCALED TO 15% RATIO)
CORM. PORT 4%

ORIGINAL PAGE IS
OF POOR QUALITY

VARIATION WITH RADIUS RATIO

ORIGINAL PAGE IS
OF POOR QUALITY

ALL RP

ALL RP

115

110

105

100

95

HFSPL

$\log V/c_a = .38$

RADIUS RATIO (FAN)

HFSP1 VARIATION WITH RADIUS RATIO 110°

$\log v/v_c = .2$

O

$\log v/v_c = .38$

□

HF SPL CORR ~ dB
(SCALED TO 15' RADIUS,
CORR. FOR AF)

115-

110 -

105

100

95

.4 .5 .6 .7 .8 .9 1.0

R_F ~ RADIUS RATIO (FAN)

□ □ □

120
(FOR ALL RP)

125

115

110

105

120

115

110

105

110

105

100

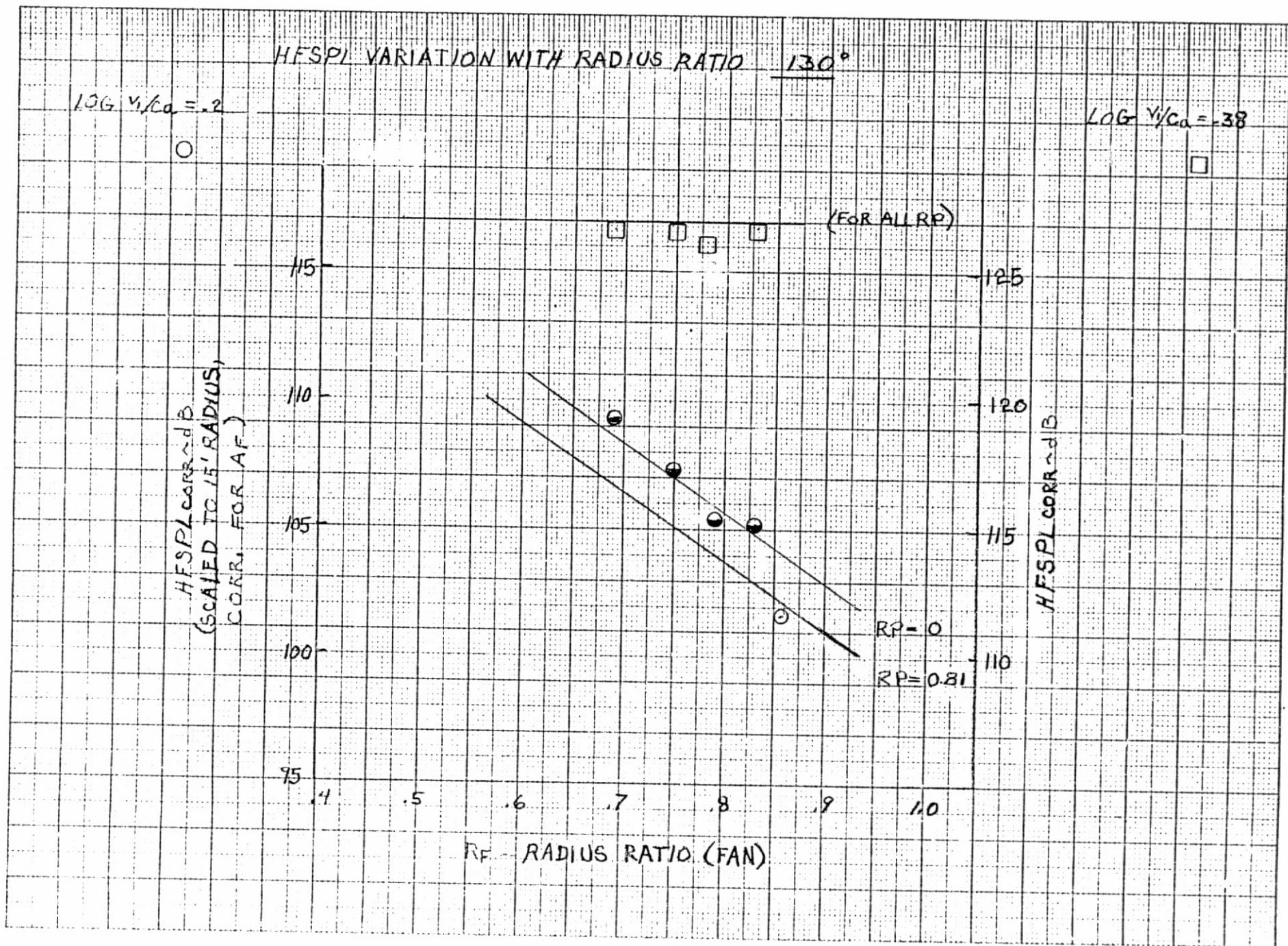
95

90

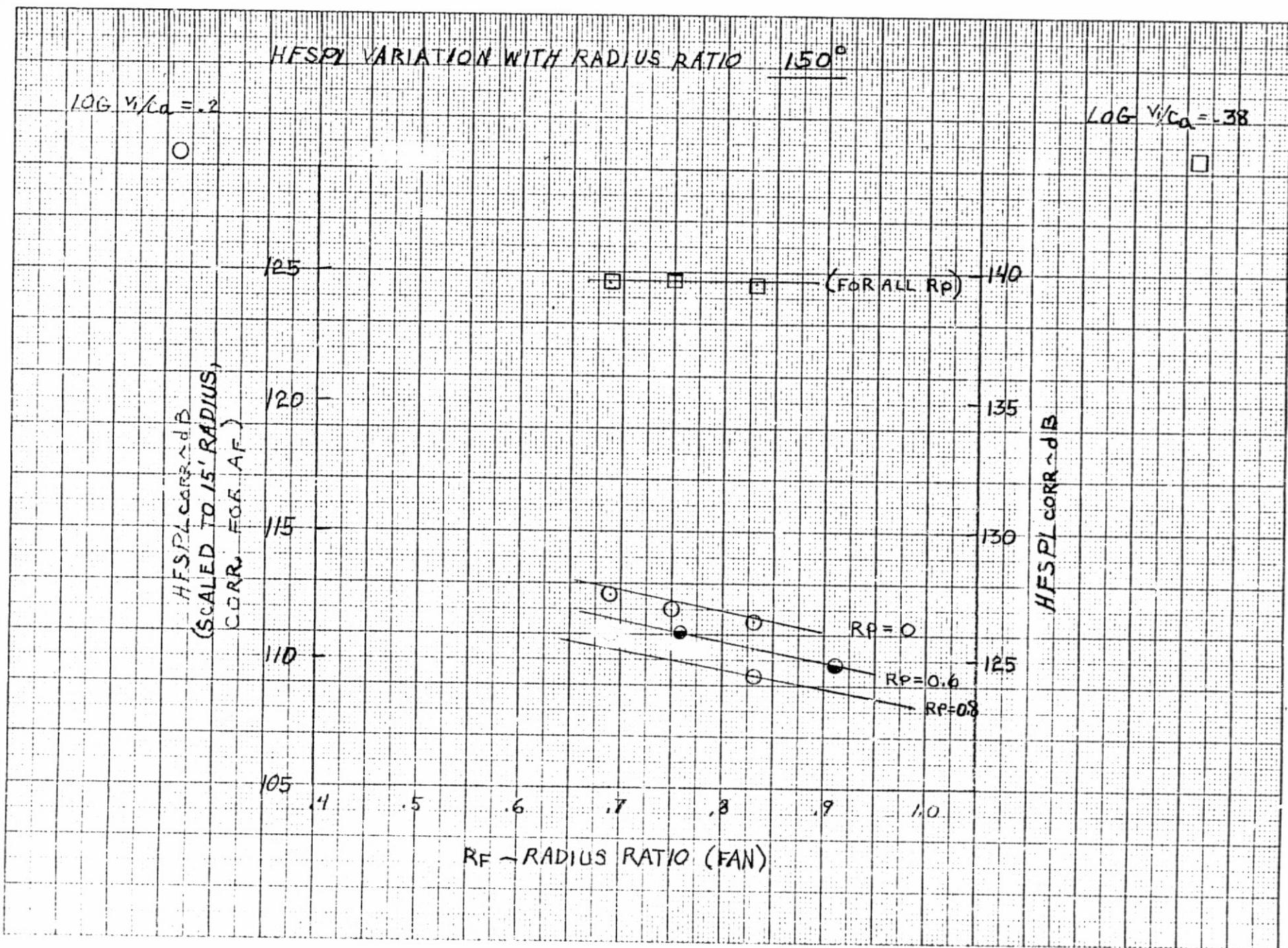
85

80

75



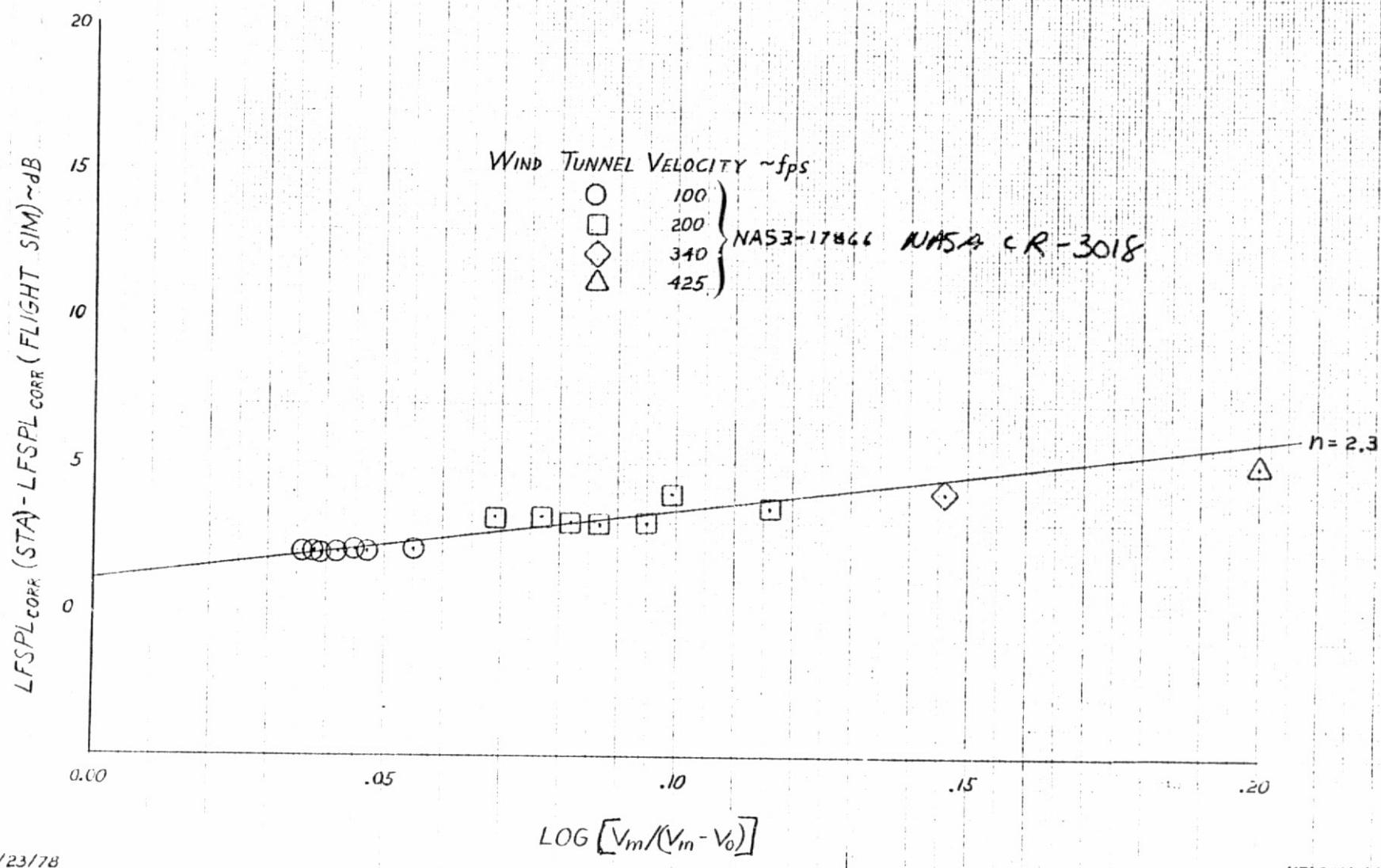
C 46



C47

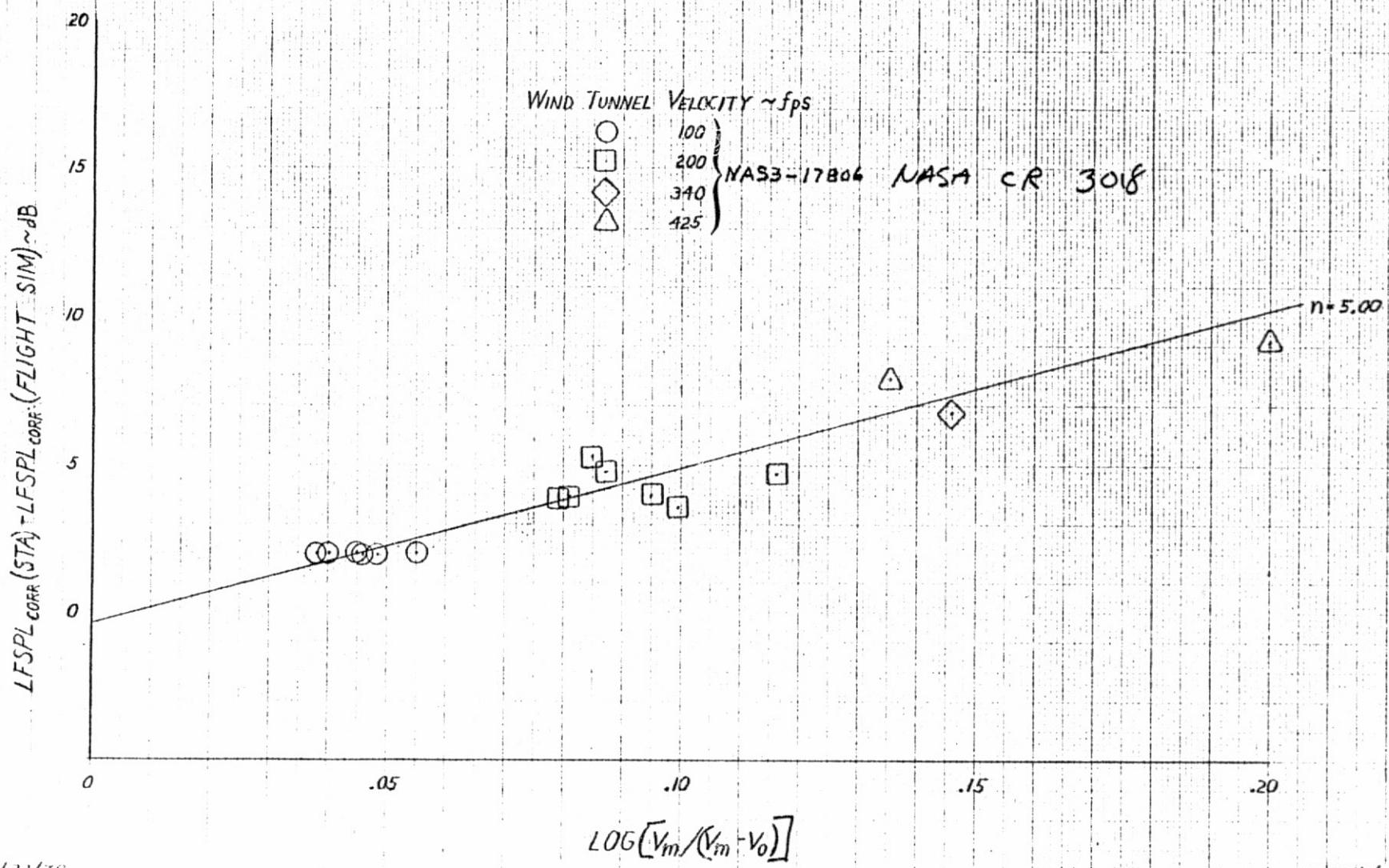
C48

CORRELATION OF THE LOW FREQUENCY MIXING NOISE COMPONENT AT
 $\theta_m = 61^\circ (70^\circ)$ WITH RELATIVE VELOCITY



C-49

CORRELATION OF THE LOW FREQUENCY MIXING NOISE COMPONENT
AT $80^\circ(90^\circ)$ WITH RELATIVE VELOCITY



2/23/78

NELSON/KB

C-50

$L_{FSPL,corr}(STA) - L_{FSPL,corr}(FLIGHT, SIM) \sim dB$

Y-axis: $L_{FSPL,corr}(STA) - L_{FSPL,corr}(FLIGHT, SIM) \sim dB$

X-axis: $\log [V_m / (V_m - V_0)]$

ORIGINAL PAGE IS
OF POOR QUALITY

CORRELATION OF THE LOW FREQUENCY MIXING NOISE COMPONENT AT
 $100^\circ(110^\circ)$ WITH RELATIVE VELOCITY

WIND TUNNEL VELOCITY ~fps

100
200
340
425

} NAS3-17866 NASA CR 3018

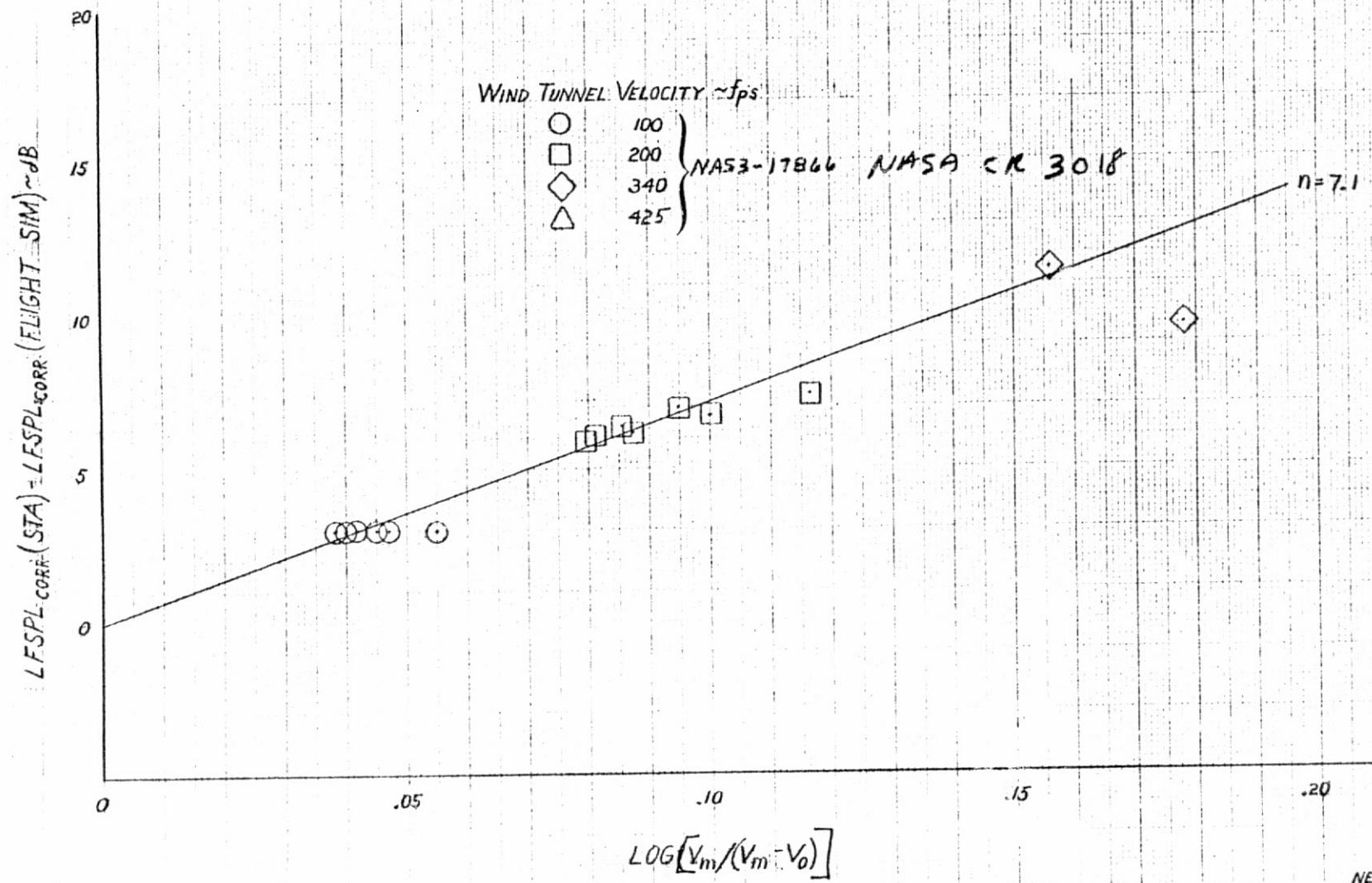
$n = 5.00$

$$\log [V_m / (V_m - V_0)]$$

2/23/78

NELSON/KB

CORRELATION OF THE LOW FREQUENCY MIXING NOISE COMPONENT AT
 122°(130°) WITH RELATIVE VELOCITY.

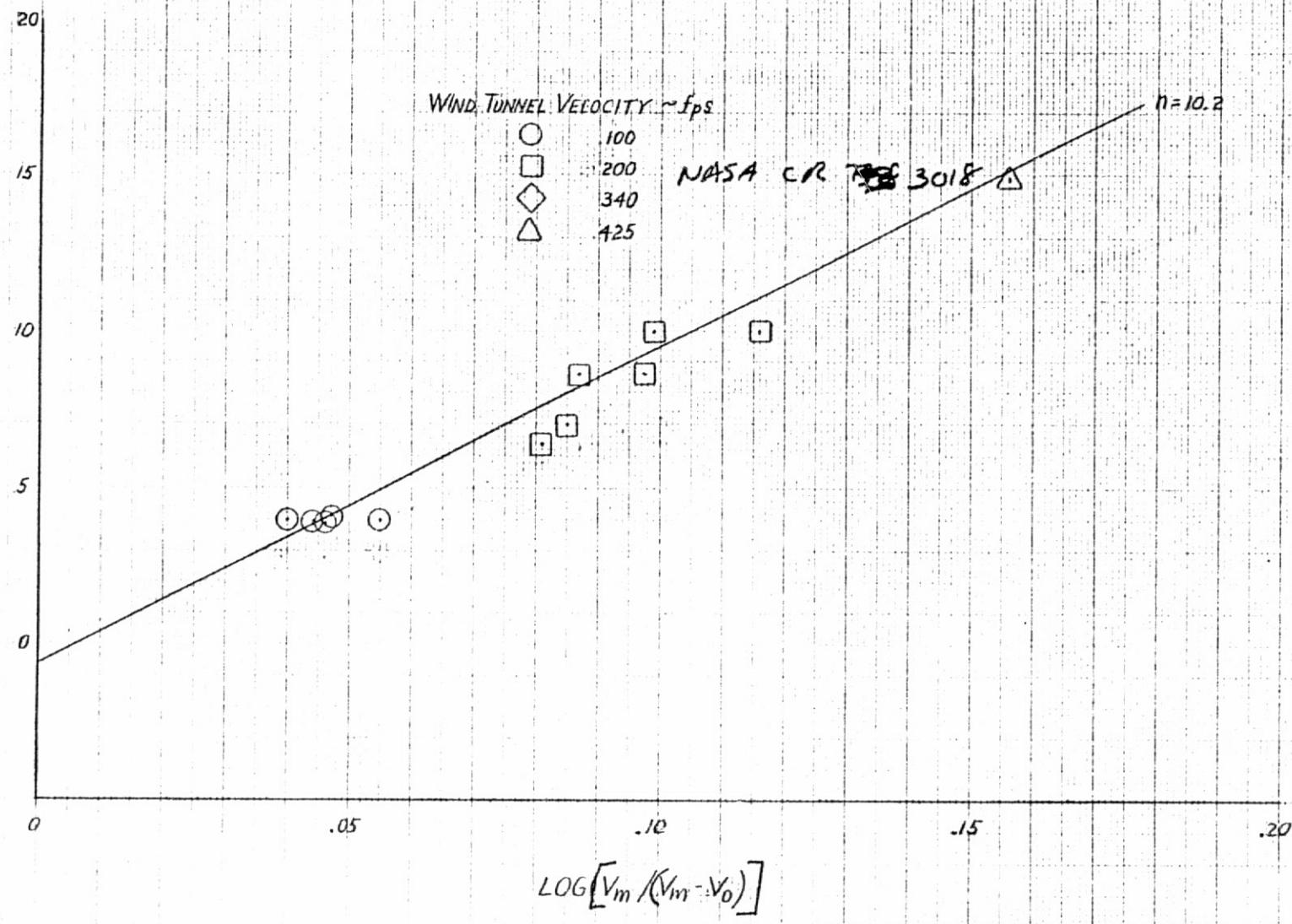


2/23/78

NELSON/KB

C-52

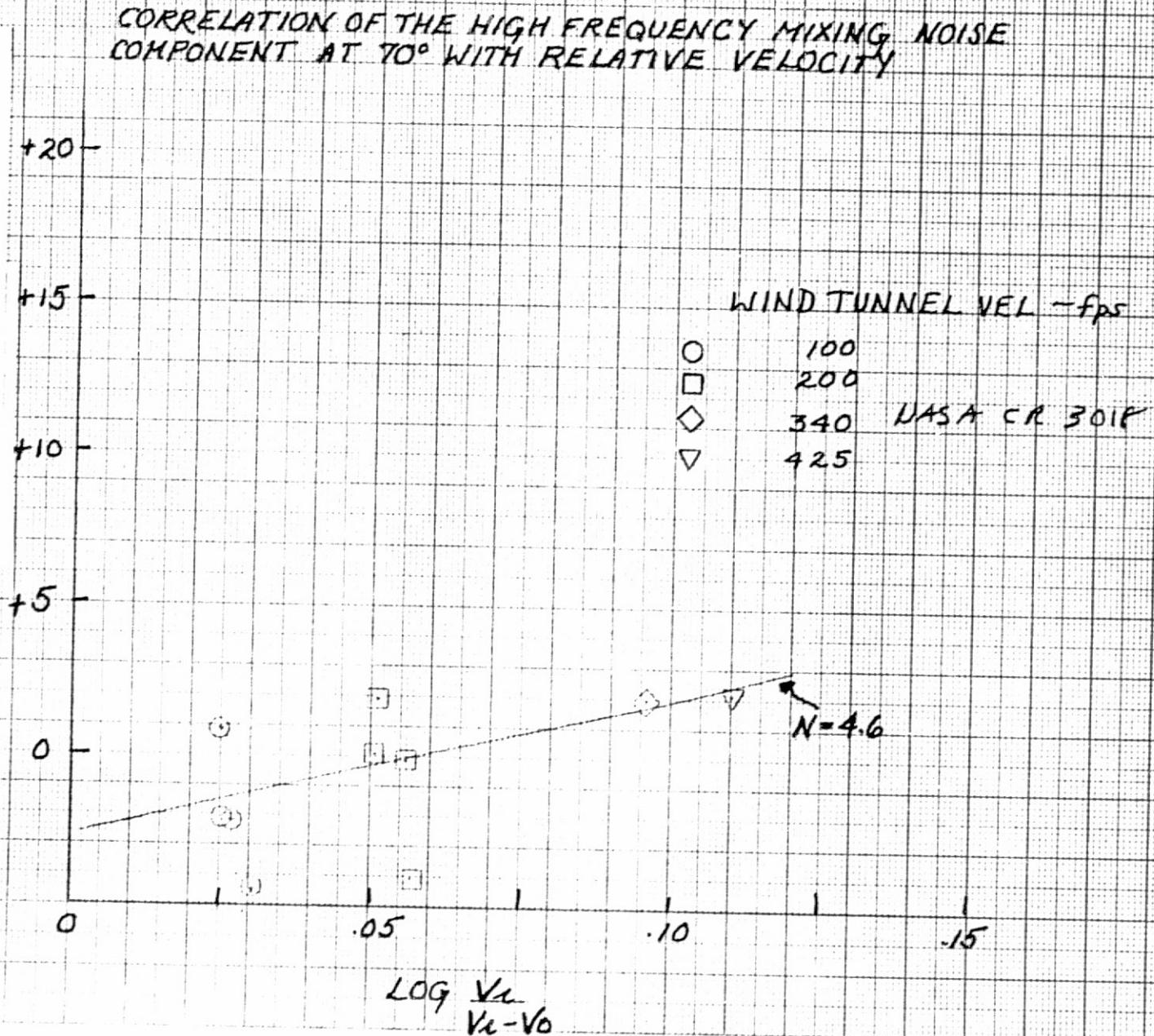
LF SPL CORR (STA) = LF SPL CORR (FLIGHT SLM) - dB



2/23/78

NELSON/KB

$HFSPL_{corr}(\text{STA}) - HFSPL_{corr}(\text{FLIGHT SIM}) \sim dB$



CORRELATION OF THE HIGH FREQUENCY MIXING NOISE
COMPONENT AT 90° WITH RELATIVE VELOCITY

$HFSPL_{CORR}(STA) - HFSPL_{FLIGHT}(SIN) \sim \delta R$

+10

+5

0

-5

-10

0

.05

.10

.15

$$L = \frac{V_f}{V_f - V_0}$$

$N = 7.4$

WIND TUNNEL VELOCITY \sim f.p.s.

100

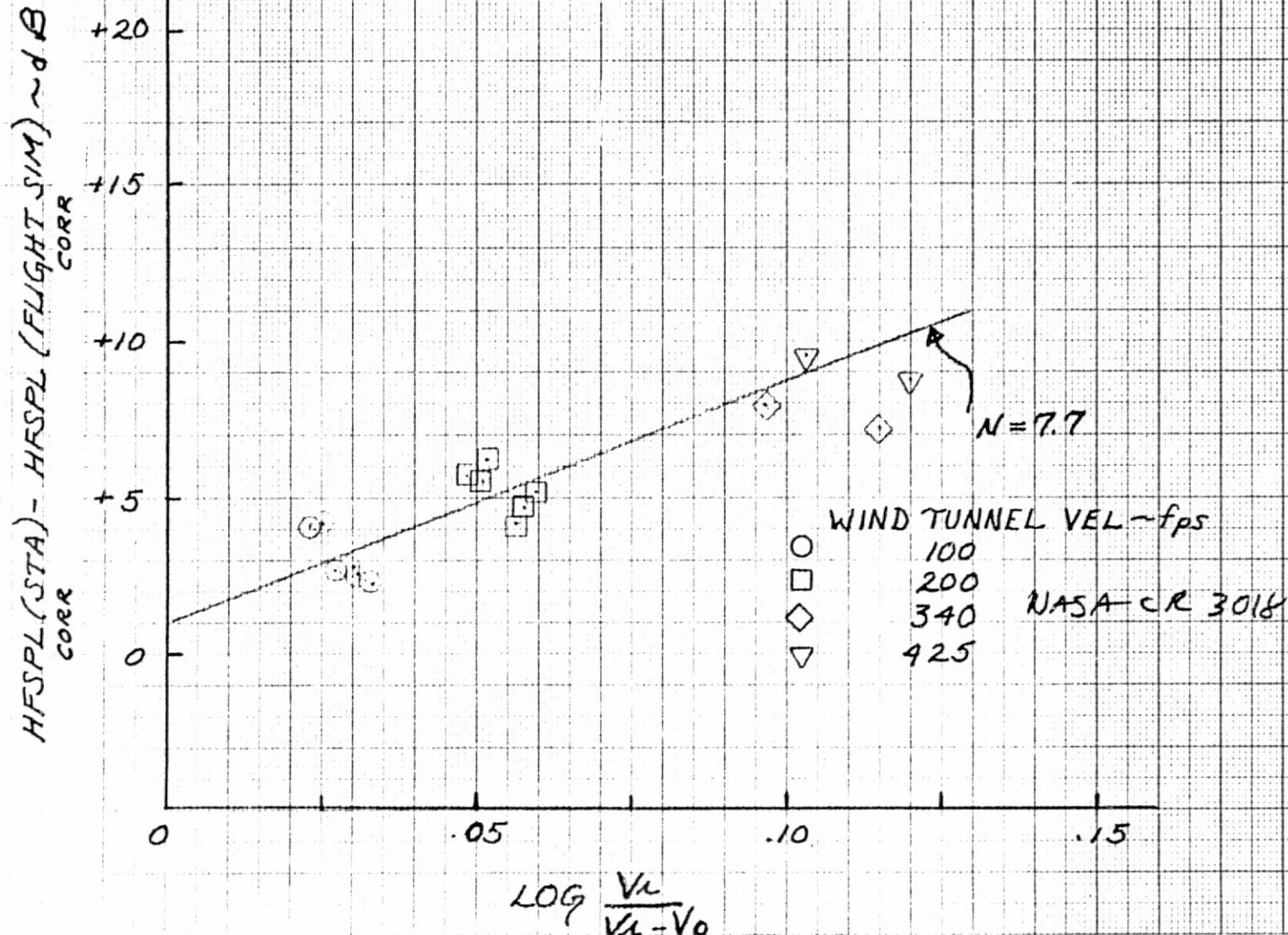
200

340

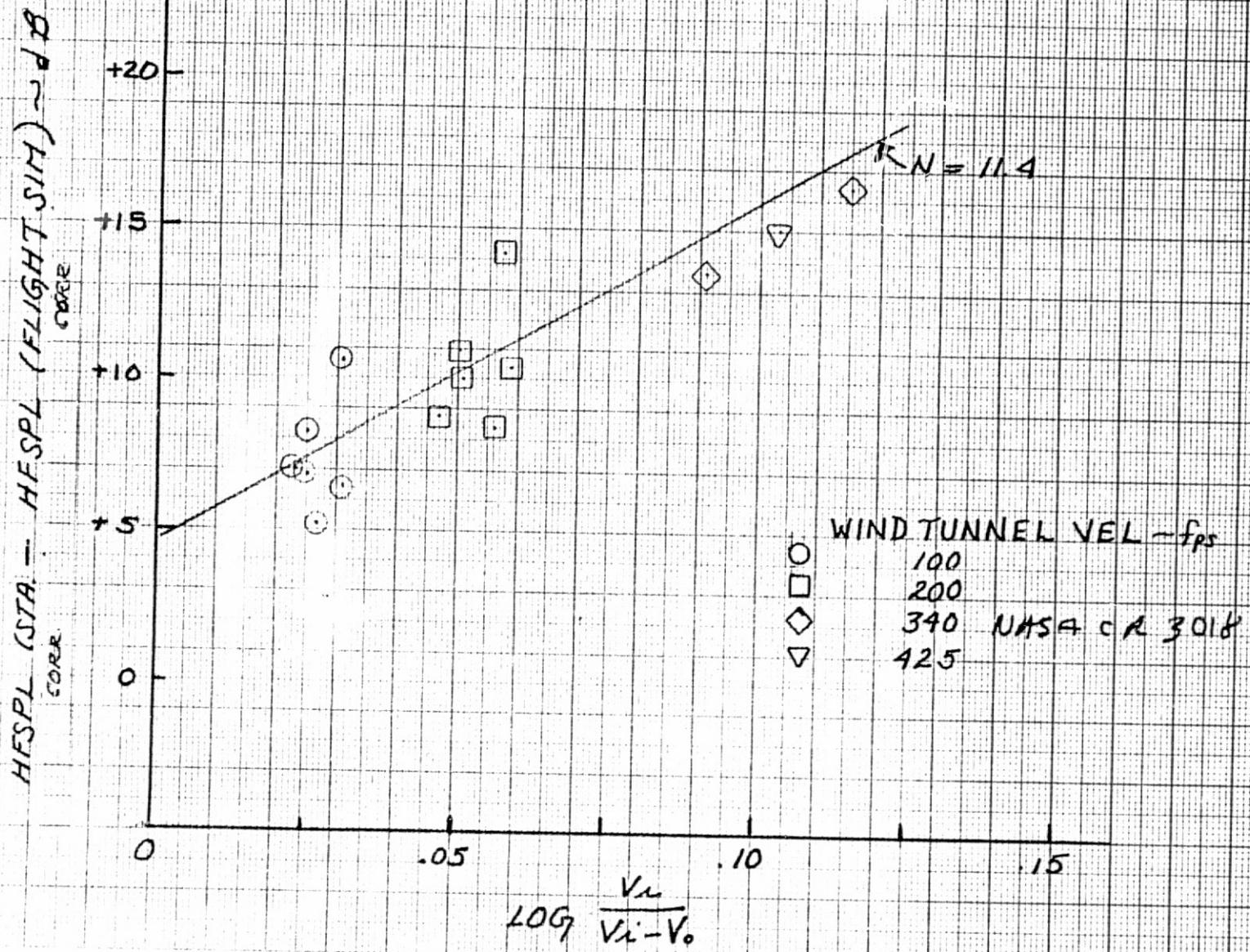
425

NASA CR 3018

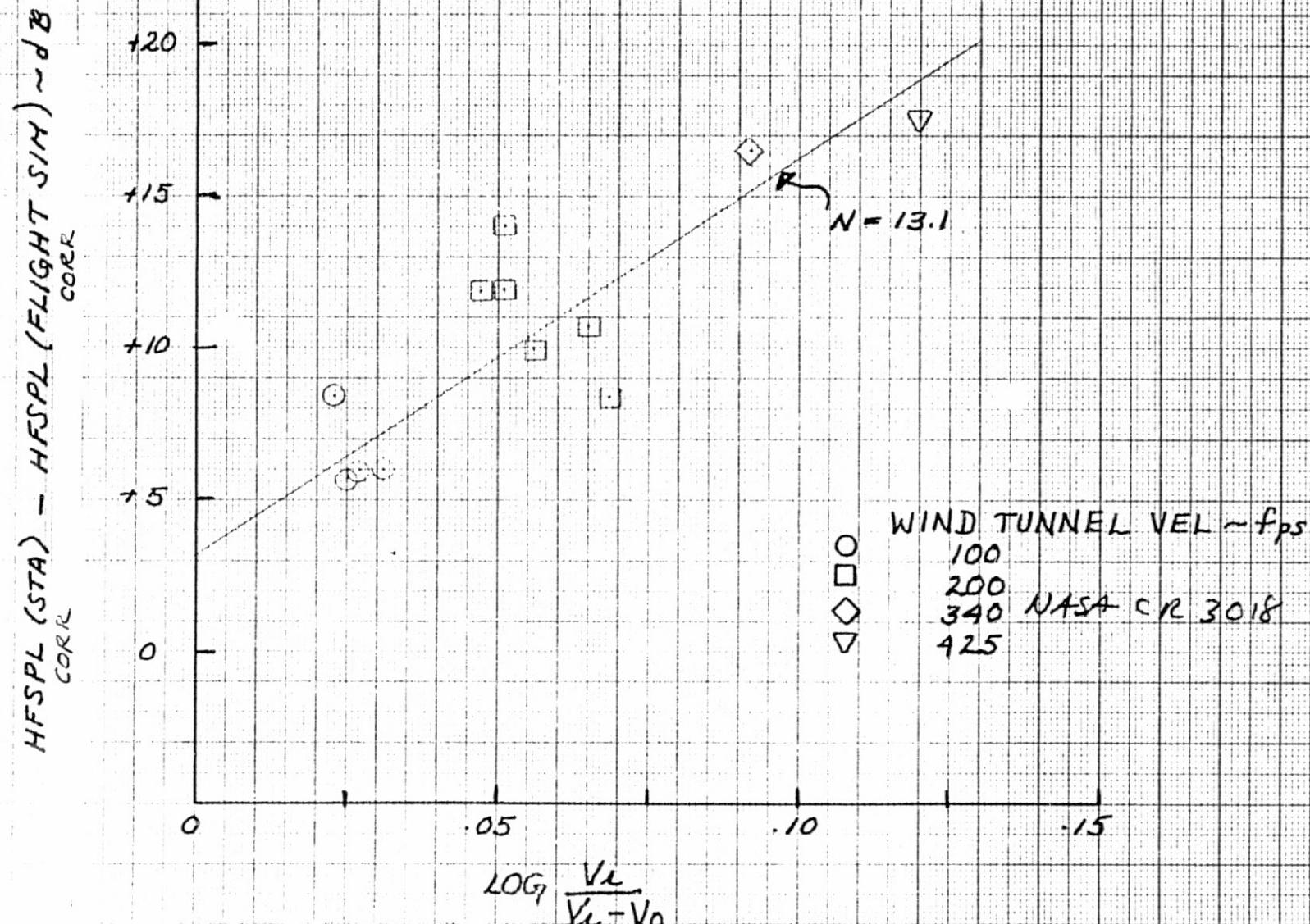
CORRELATION OF THE HIGH FREQUENCY MIXING NOISE
COMPONENT AT 110° WITH RELATIVE VELOCITY

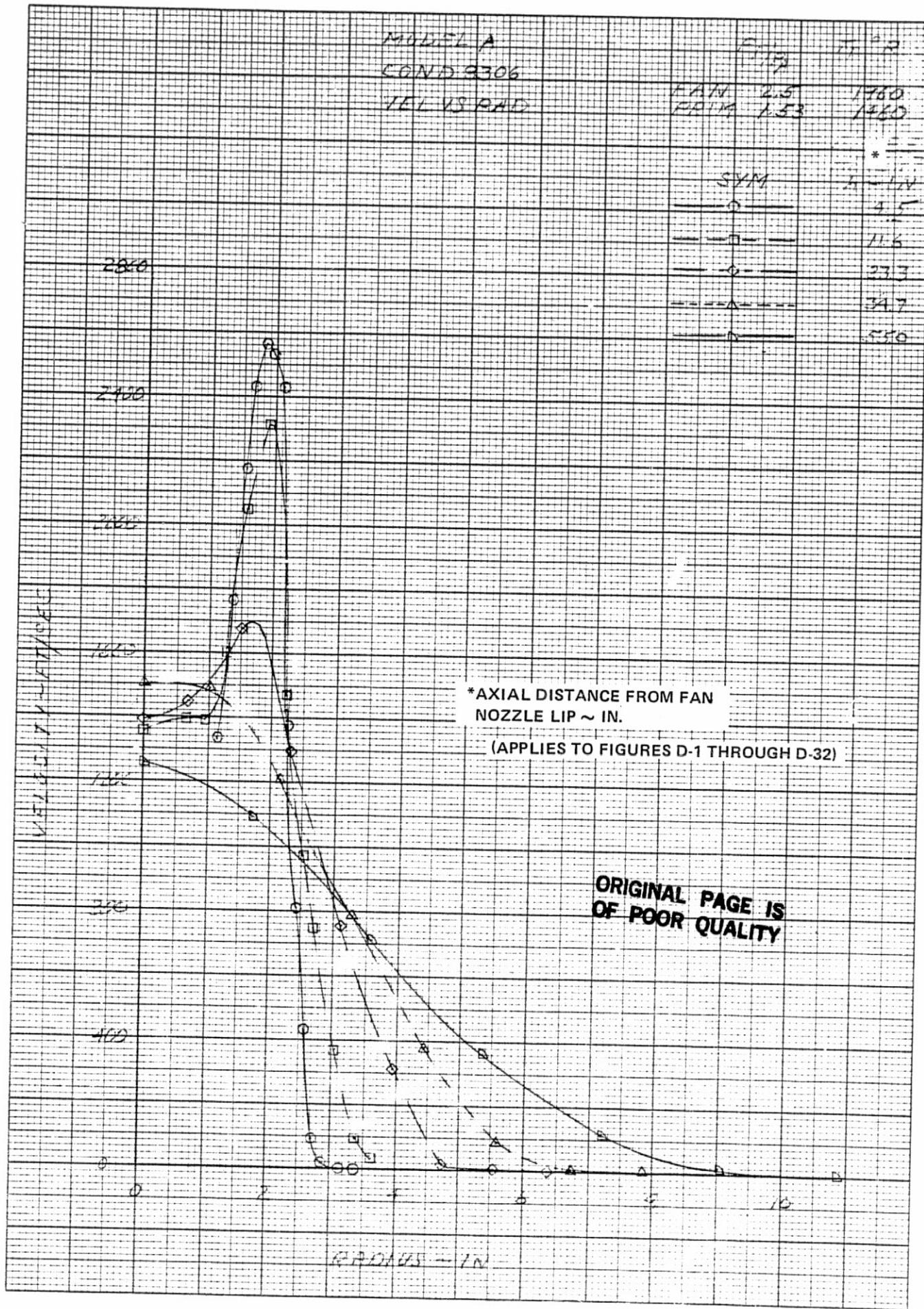


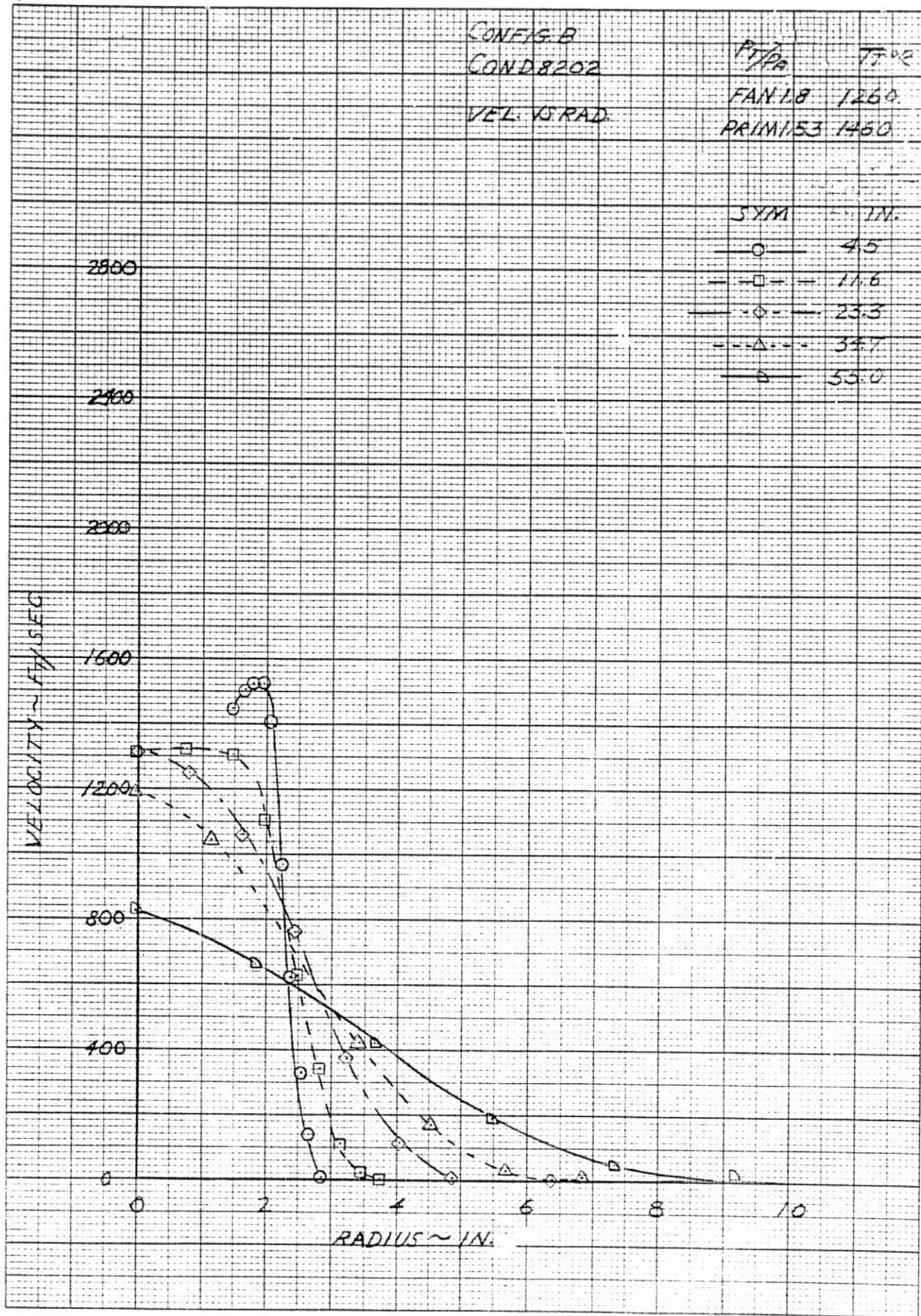
CORRELATION OF THE HIGH FREQUENCY MIXING NOISE
COMPONENT AT 130° WITH RELATIVE VELOCITY



CORRELATION OF THE HIGH FREQUENCY MIXING NOISE
COMPONENT AT 150° WITH RELATIVE VELOCITY

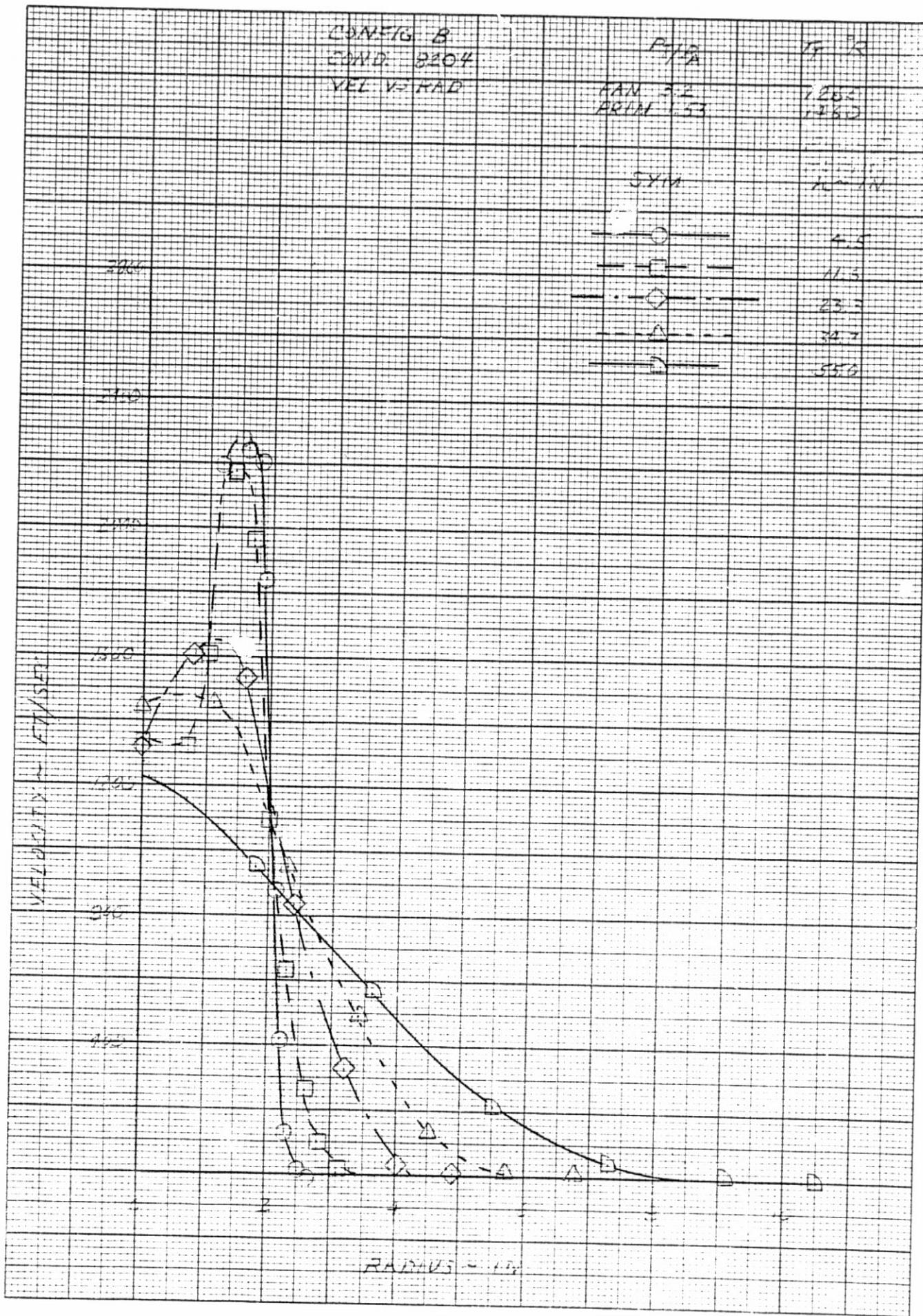


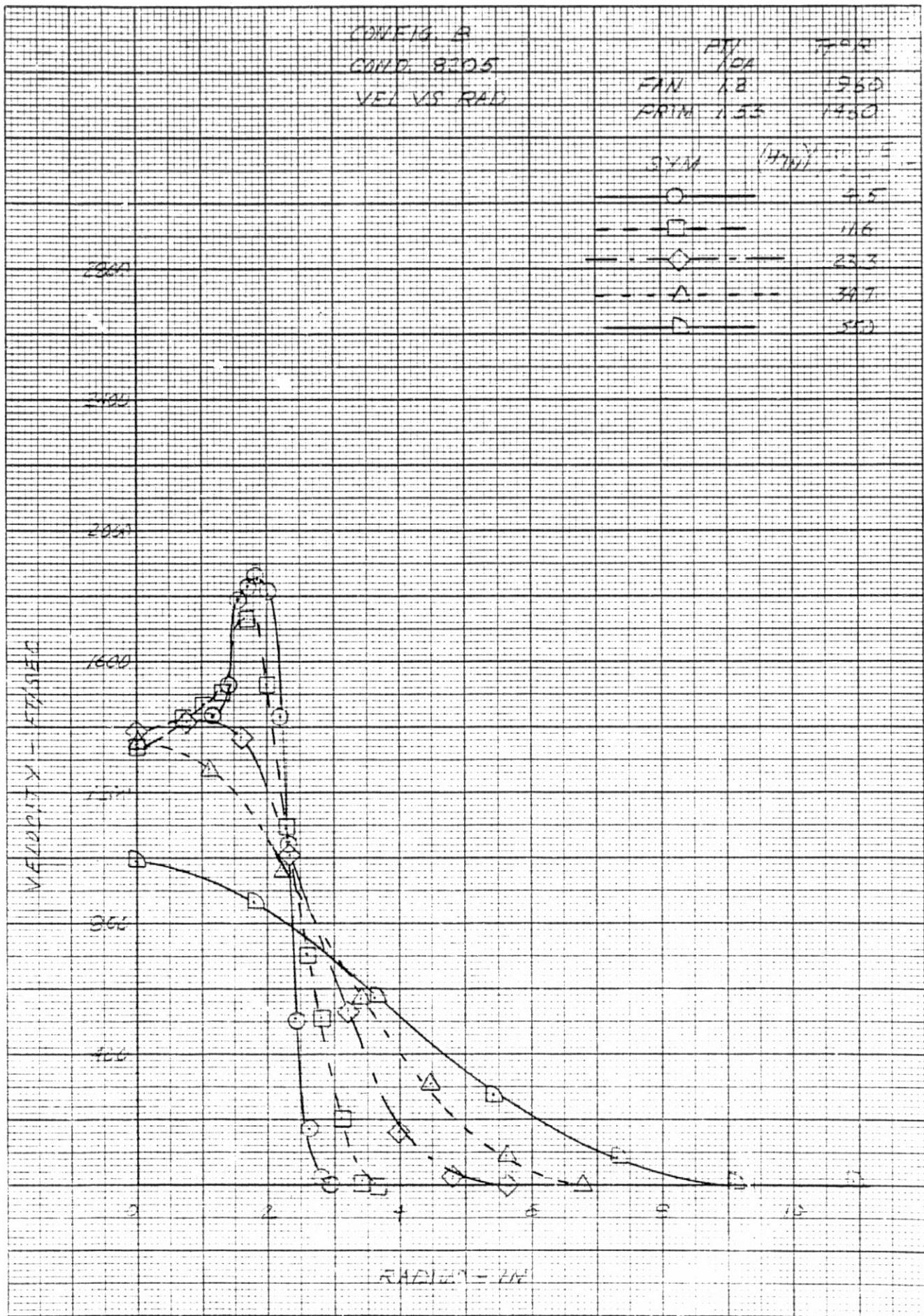




EFFECTS OF CROWN RATIO ON PLANT GROWTH 113

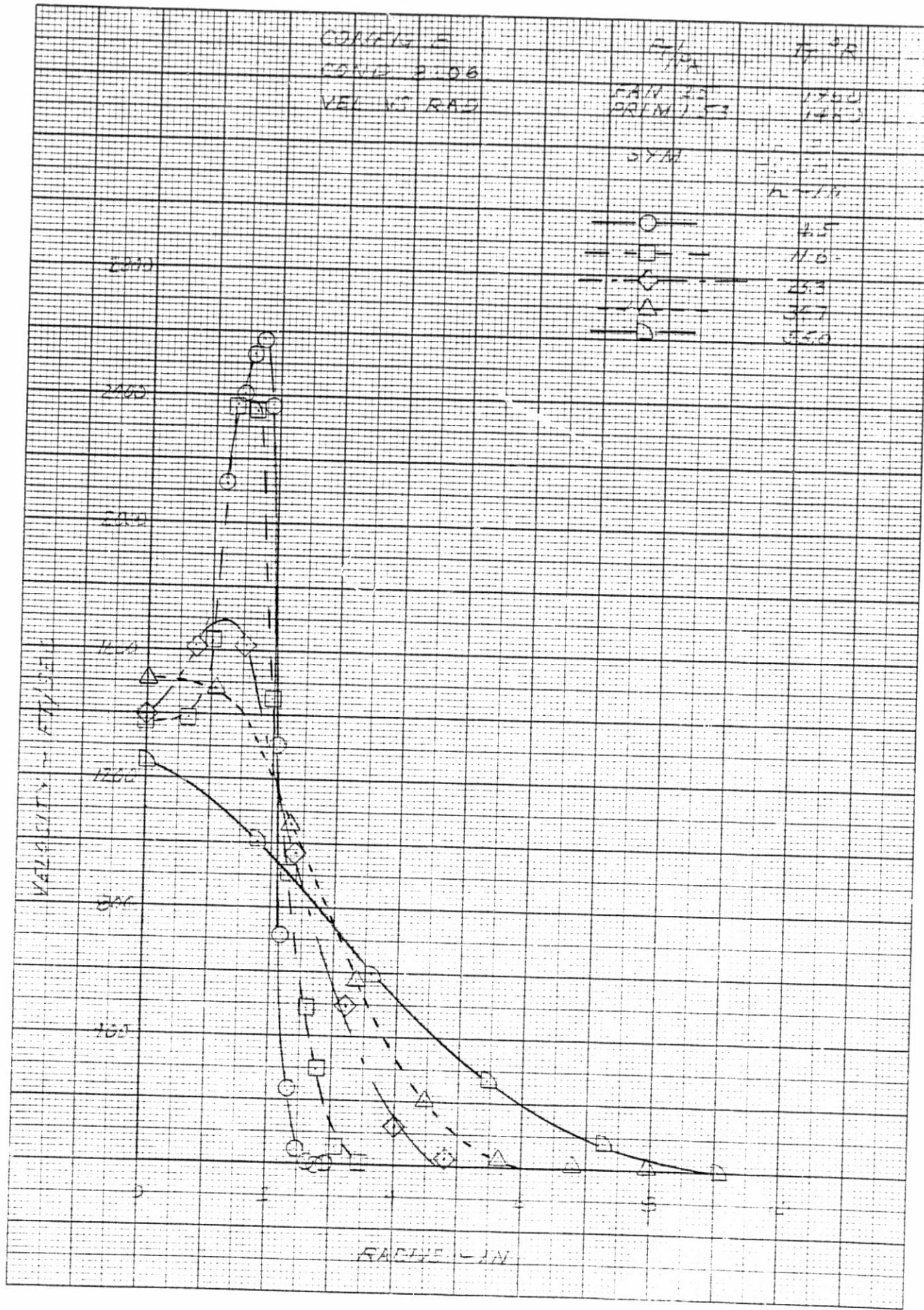
SQUARE 10 X 10 TO THE HALF INCH AS-0813-01

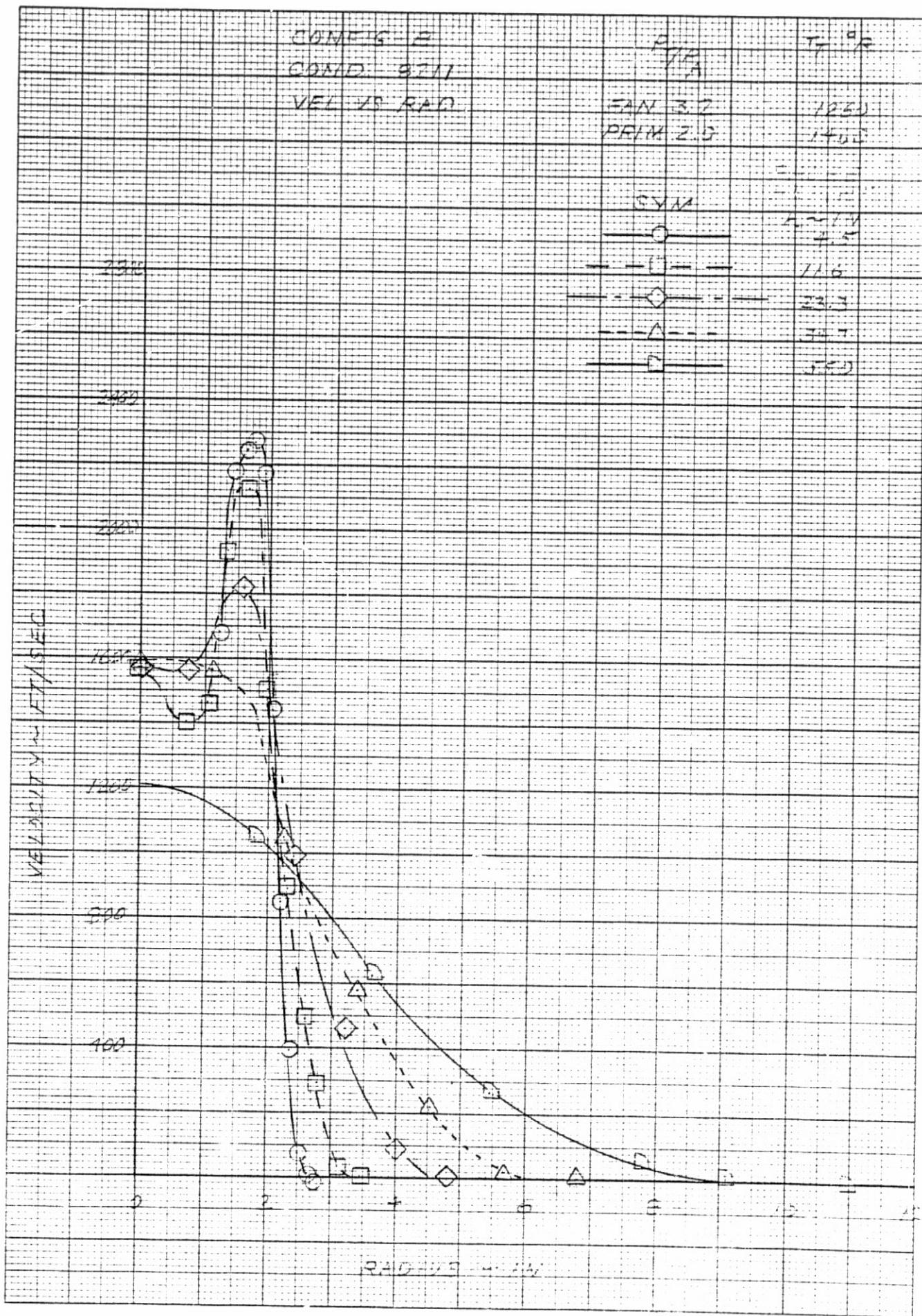




SQUARE 10 X 10 TO THE HALF INCH AS-0811-01

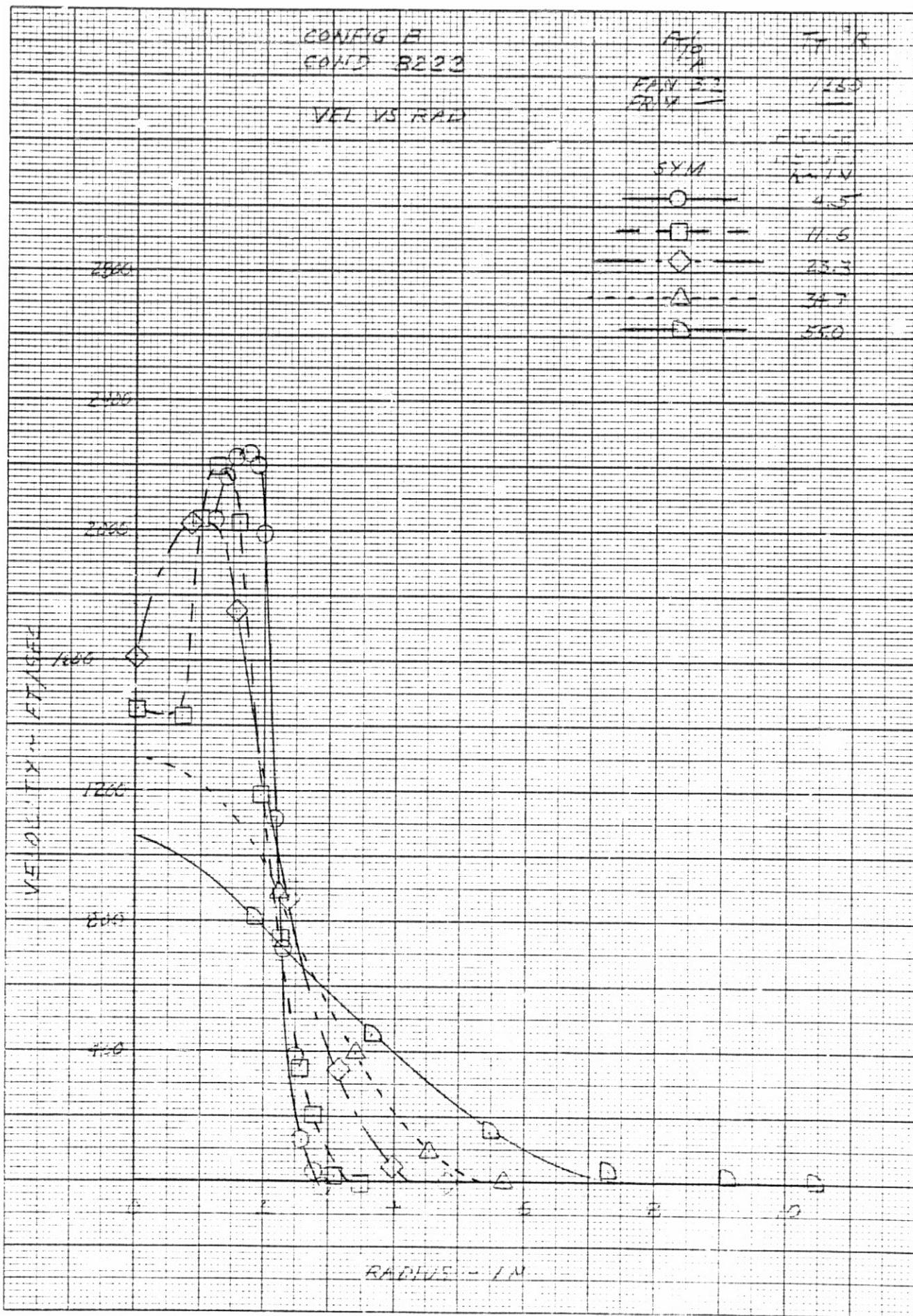
Ergonomics in Design 199

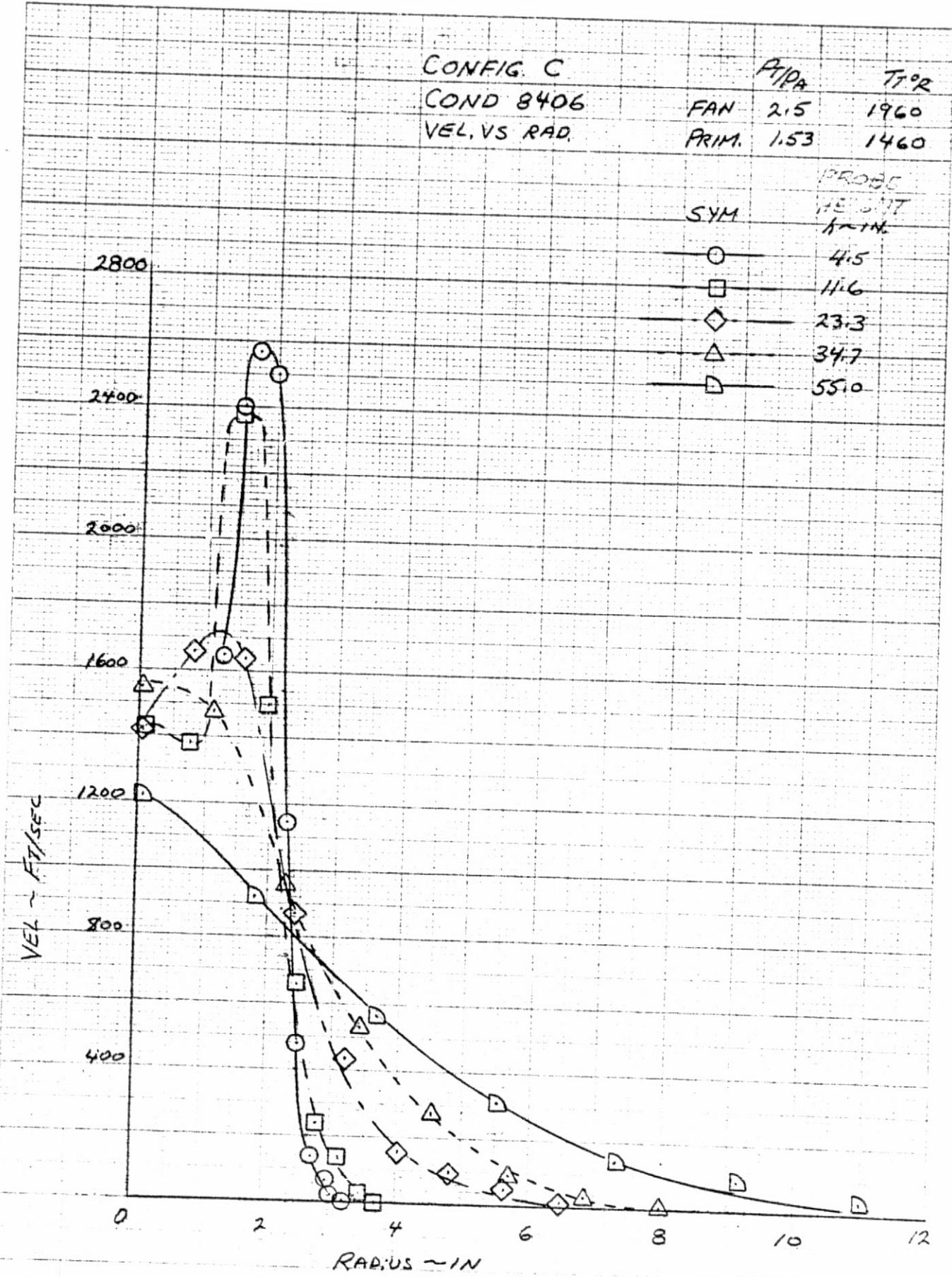




SQUARE 10 X 10 TO THE HALF INCH AS 0812-01

THE JOURNAL OF CLIMATE





MODEL D
COND. 8502
VEL V.S. RAD

P_1/Pa T_{T92}

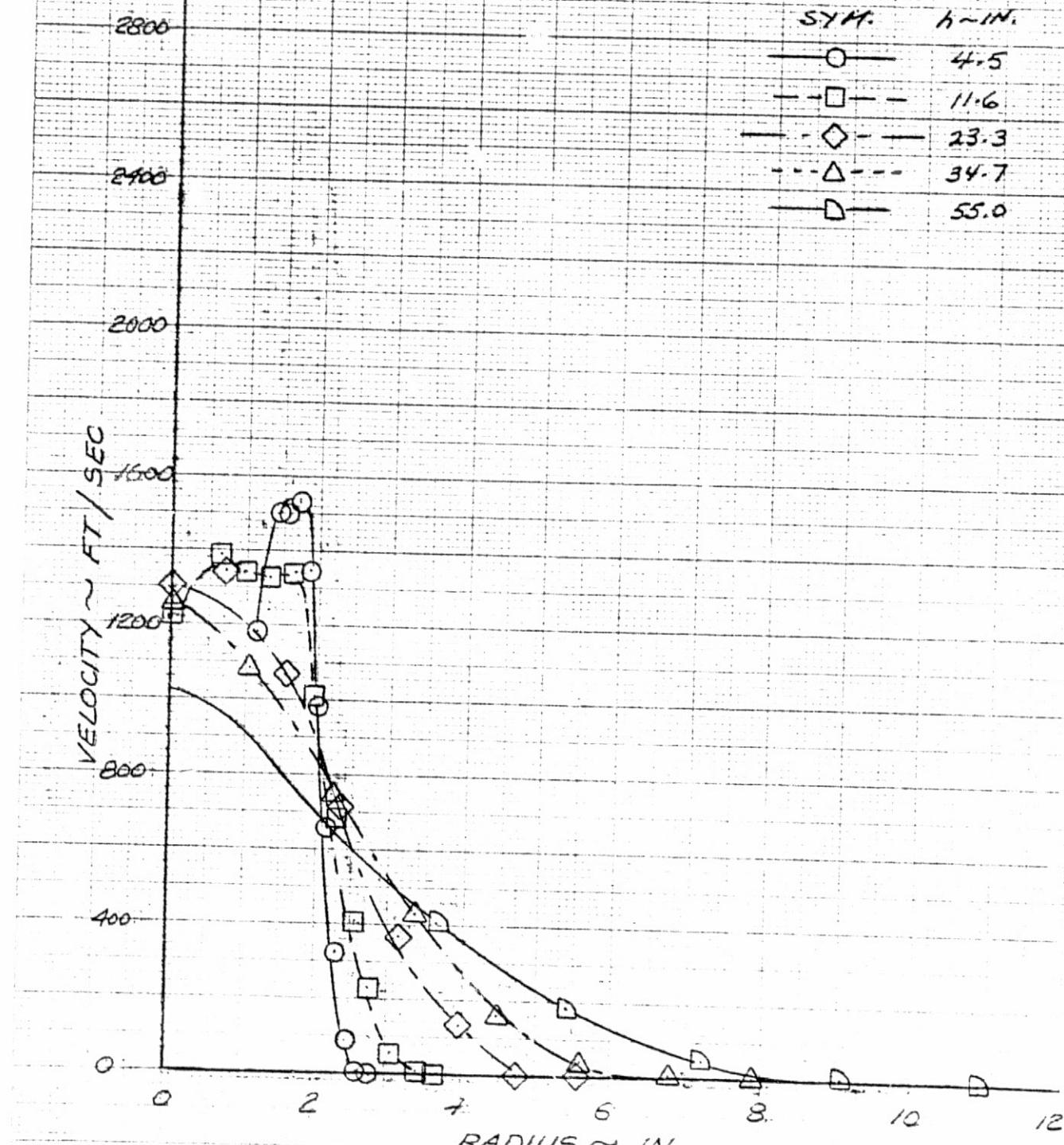
FAN 1.8 1260
PRIM 1.53 1460

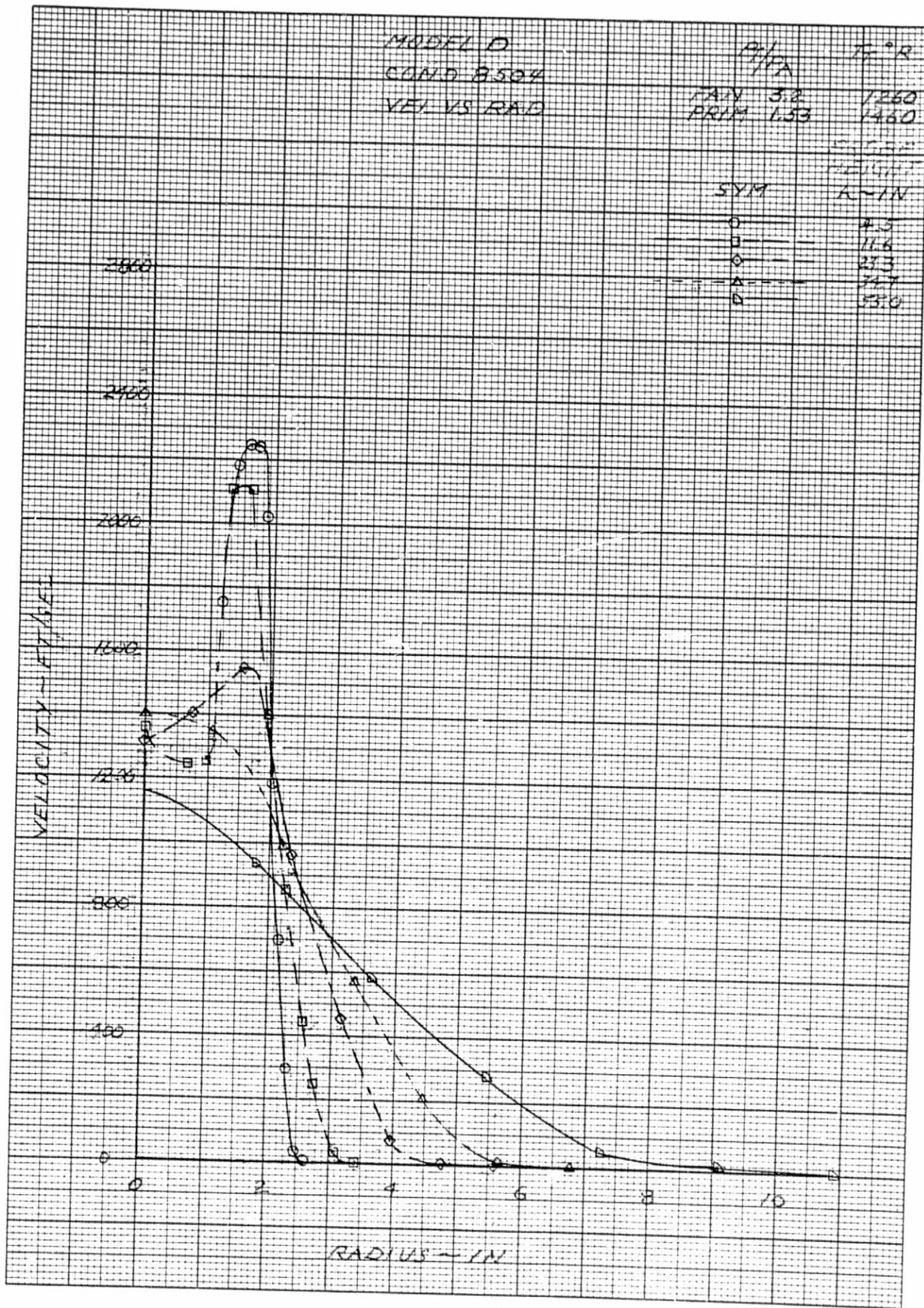
PROF.

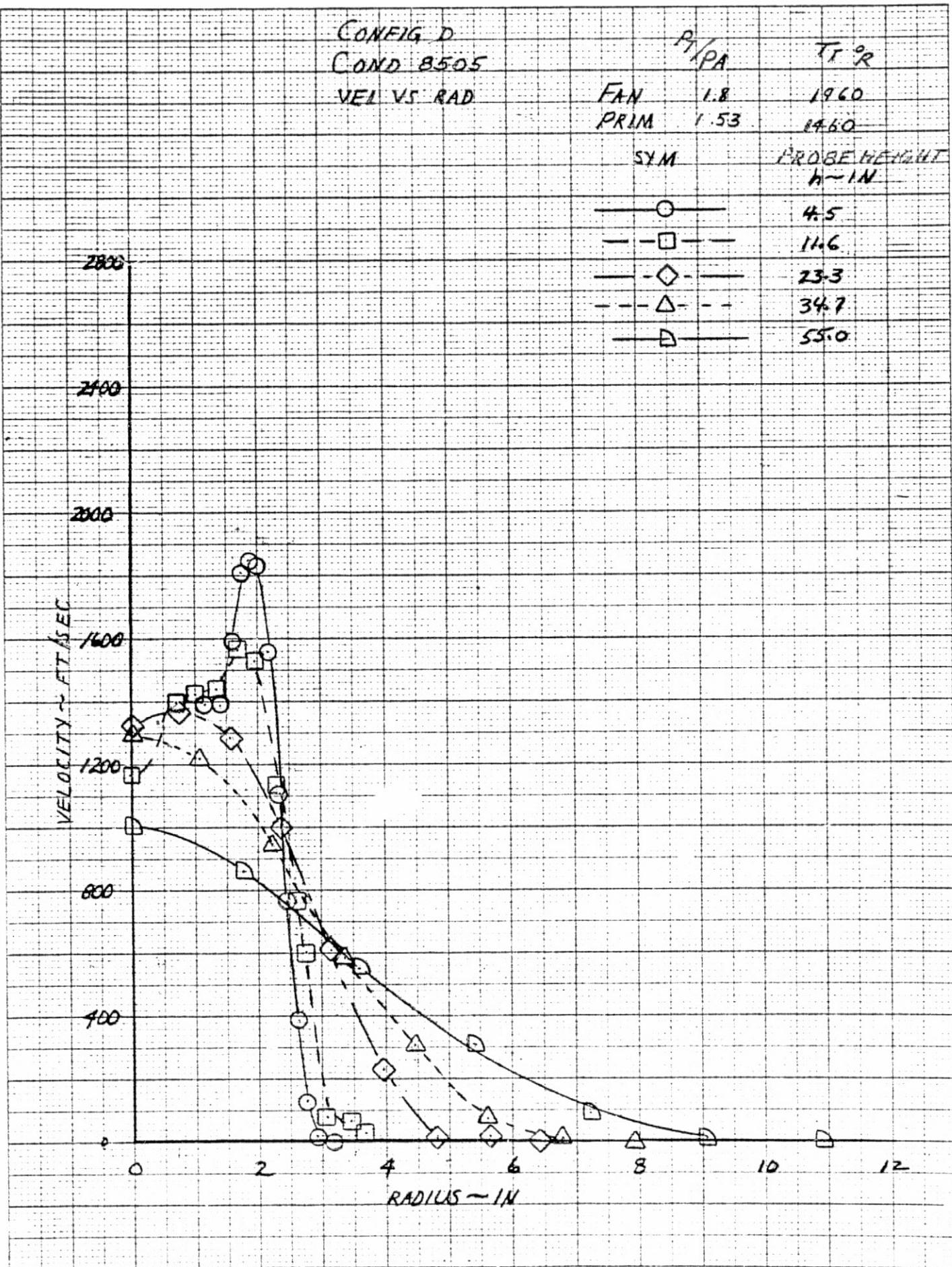
42.545

SYM. $h \sim \text{IN.}$

—○—	4.5
—□—	11.6
—◇—	23.3
—△—	34.7
—□—	55.0

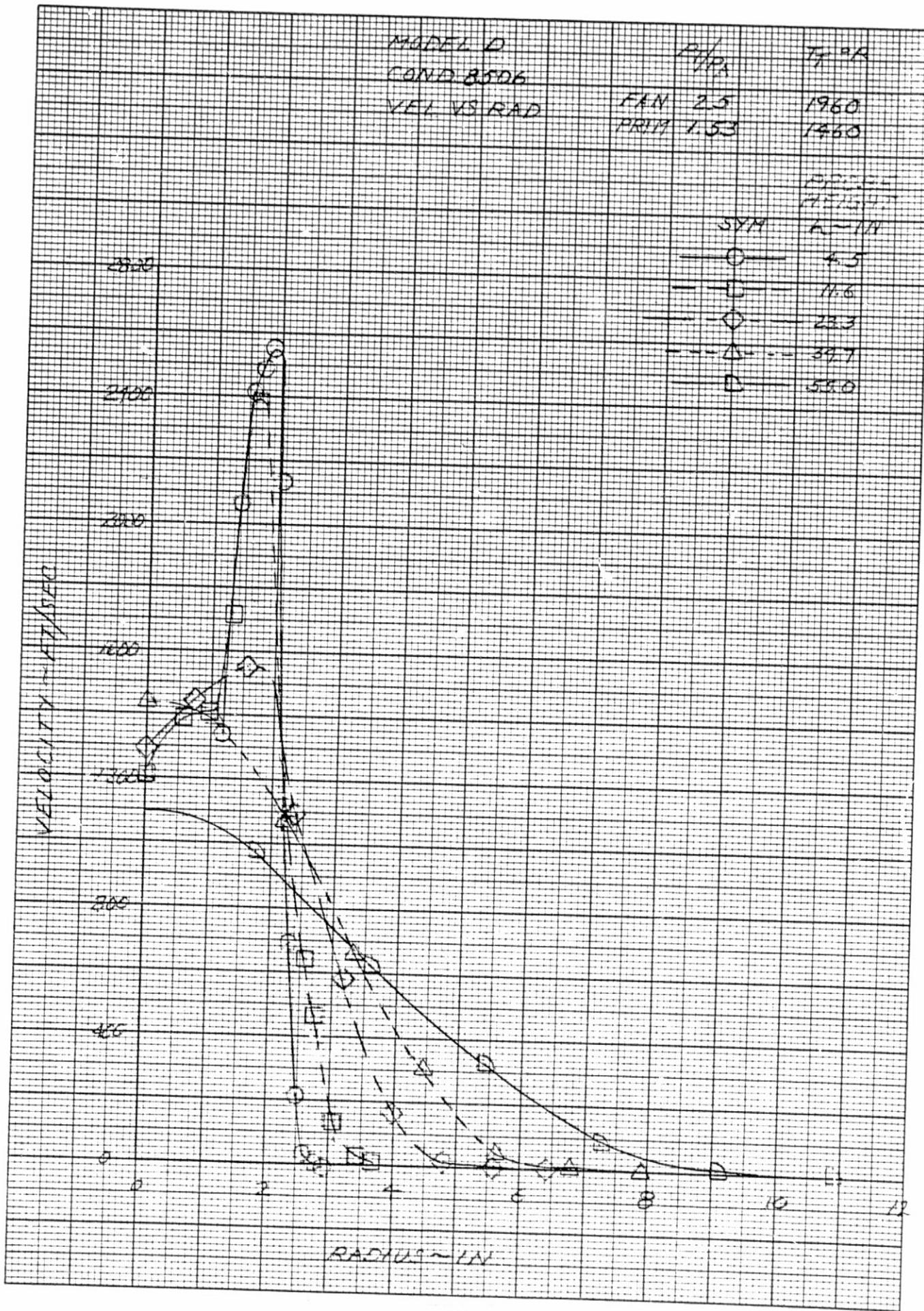






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SQUARE 10 X 10 TO THE HALF INCH AS-00011-01



MODEL D

COND. 8511

VEL. VS RAD.

FAN P_{TIP} 3.2 1760

PRIM 2.0 1460

PROBE

145 GWT

1 - IN.

4.5

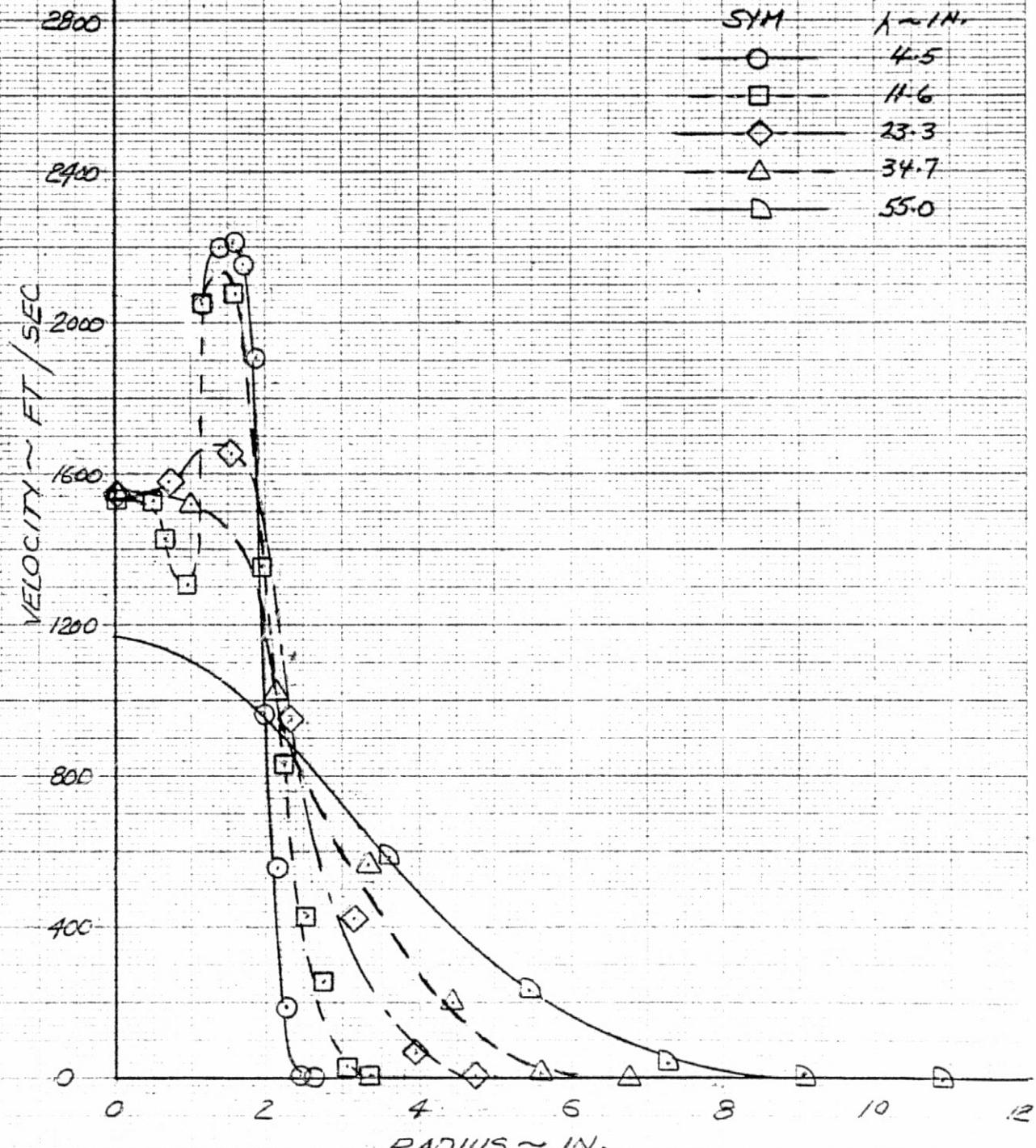
11.6

23.3

34.7

55.0

SYM



MODEL D
COND 8522

P_f/P_a T_f/T_R
FAN 3.2 1260
PRIM - - -

VEL. VS RAD

FROST
HEIGHT

SYN $h \sim 1\text{in}$

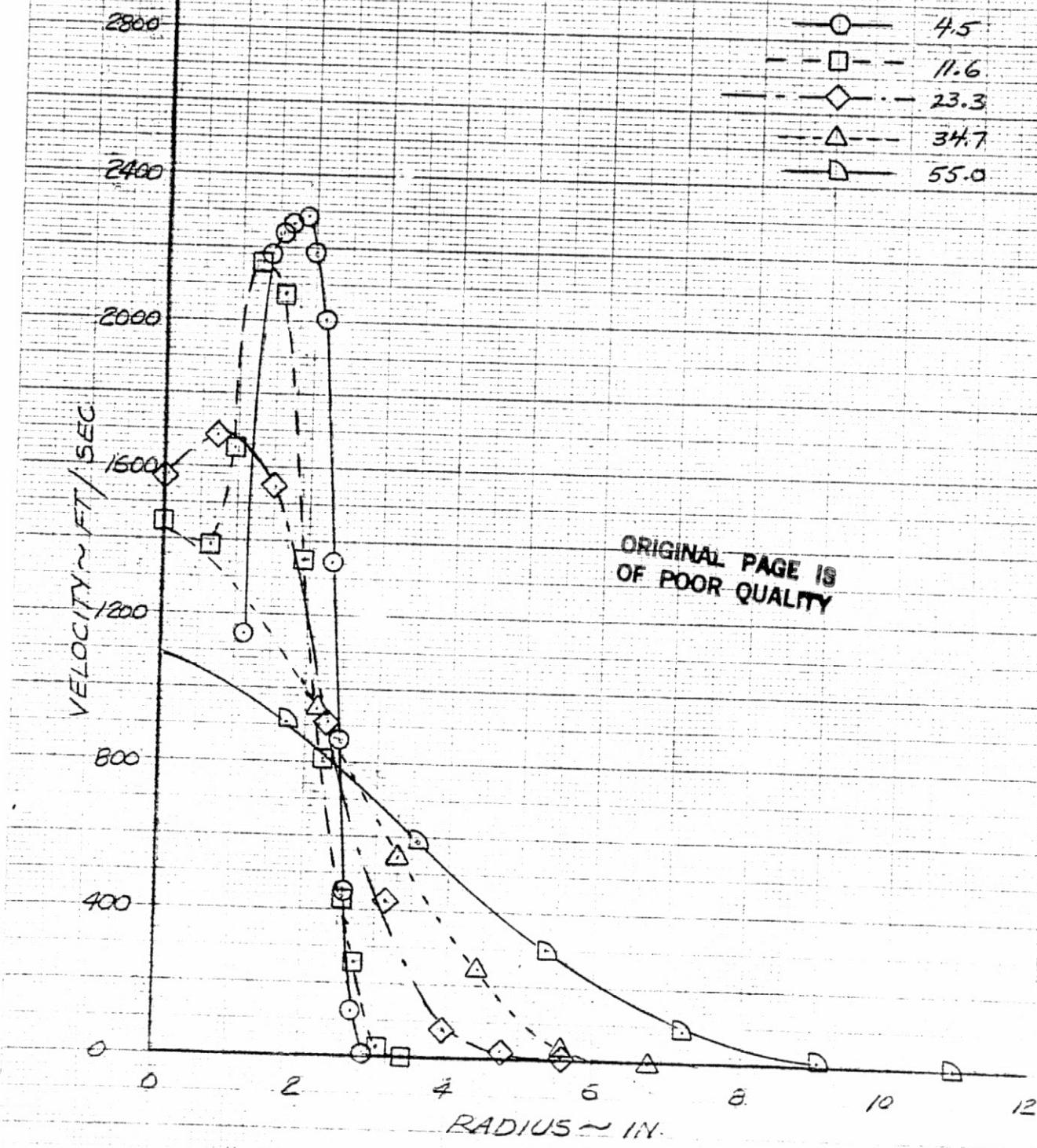
4.5

11.6

23.3

34.7

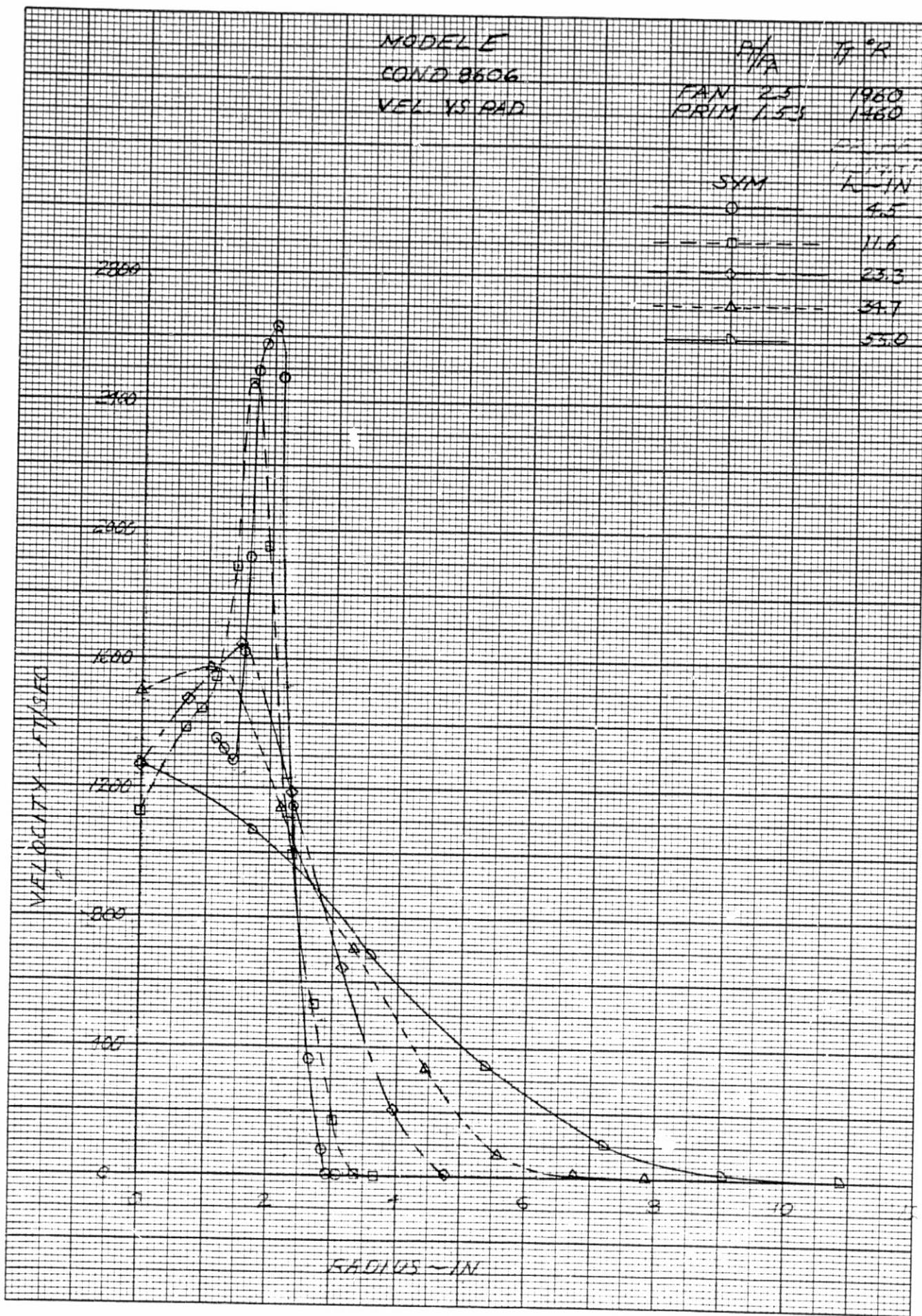
55.0



MODEL E
COND 8606
VEL VS RAD

P/PA / T °R
FAN 25 1900 1460
PRIM 1525

SYM	R IN
○	4.5
□	11.6
△	23.3
▲	34.7
■	53.0



MODEL
COND 8629

P_1/P_A $T_f^{\circ}R$

FAN —
PRIME 3.2 1260

VEL VS RAD

VELOCITY - FT/SEC

2800

2400

2000

1600

1200

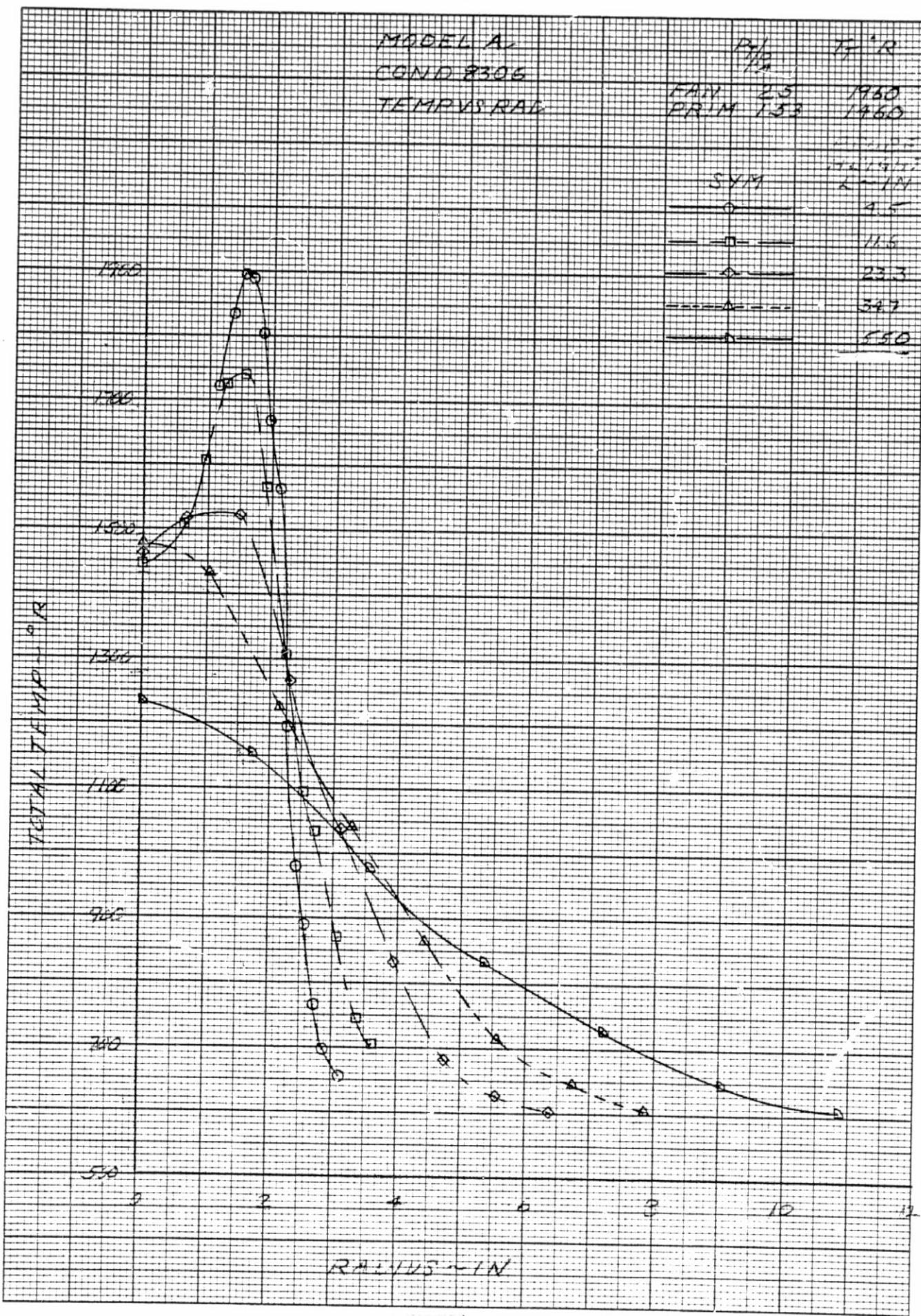
800

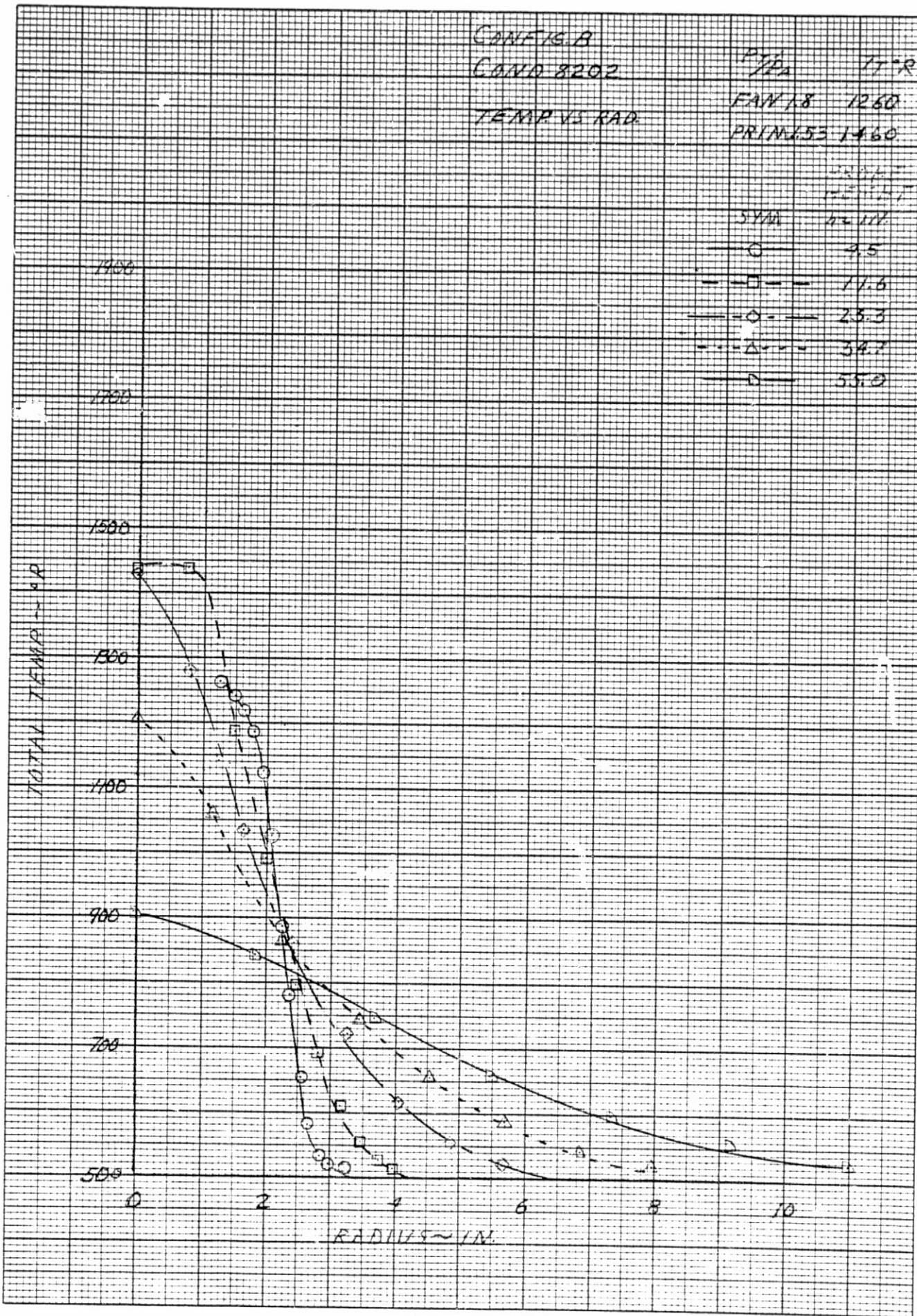
400

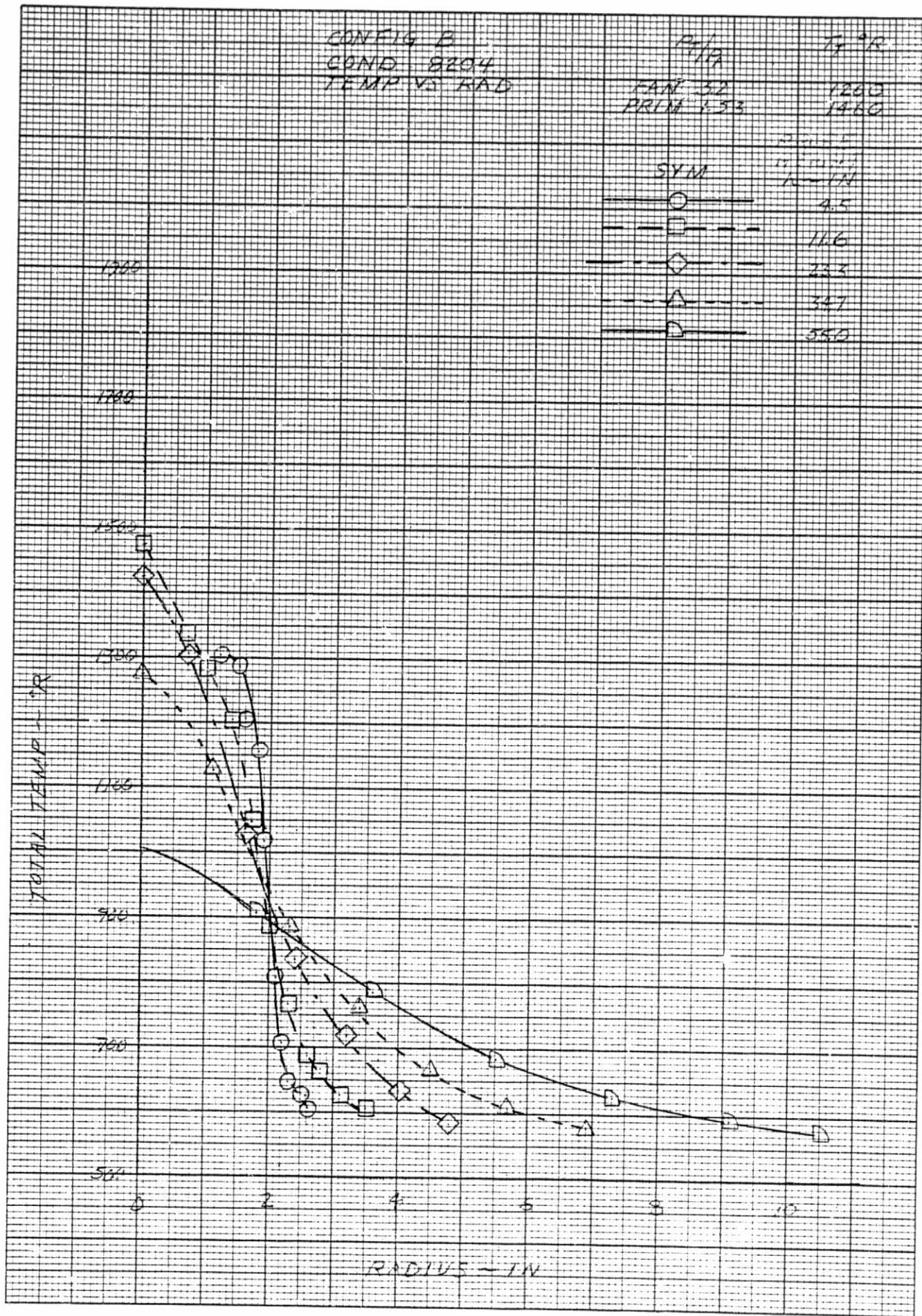
0

RADIUS - IN

SYM	K-IN
○	4.5
□	11.6
◇	23.5
△	34.7
■	55.0

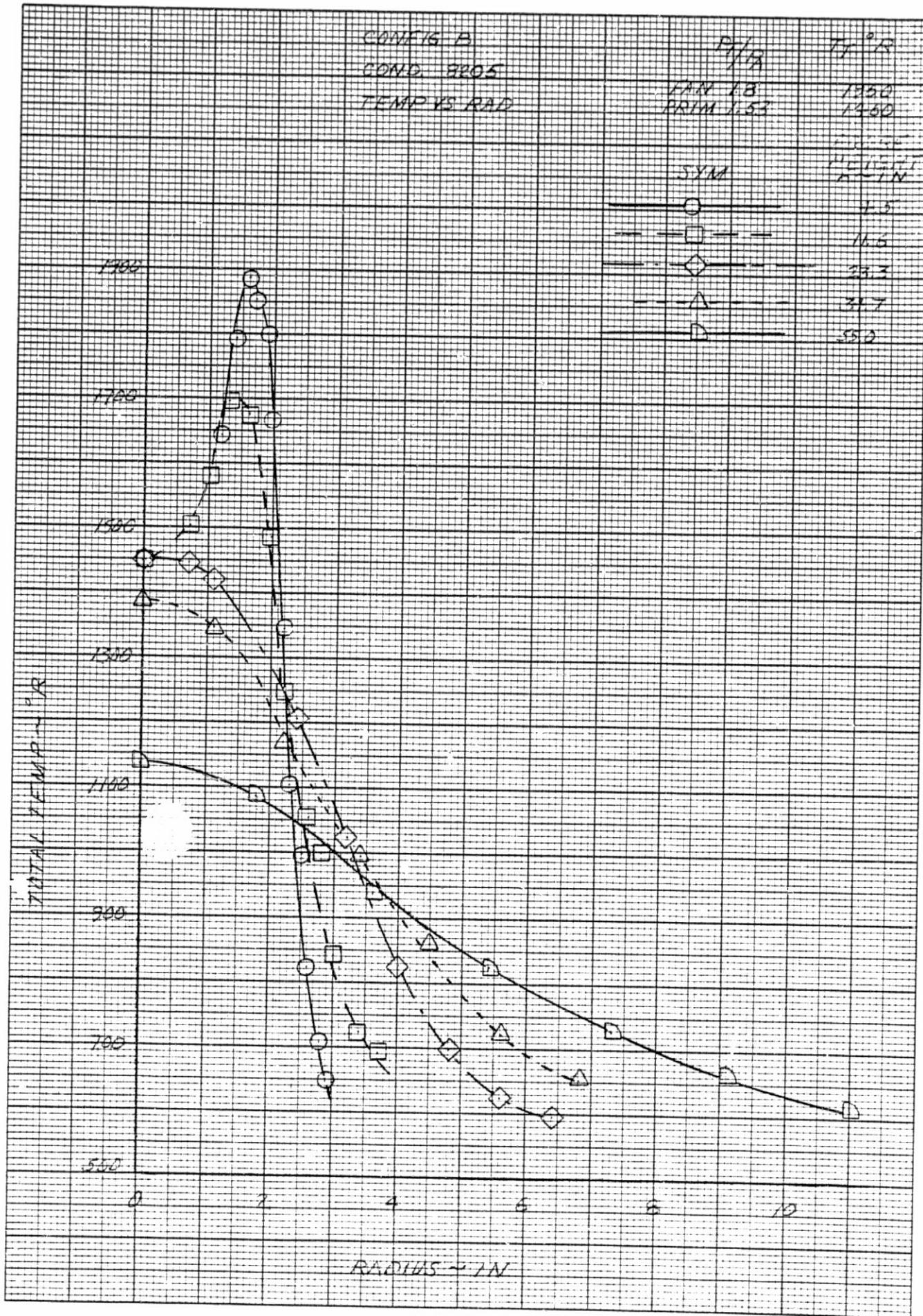


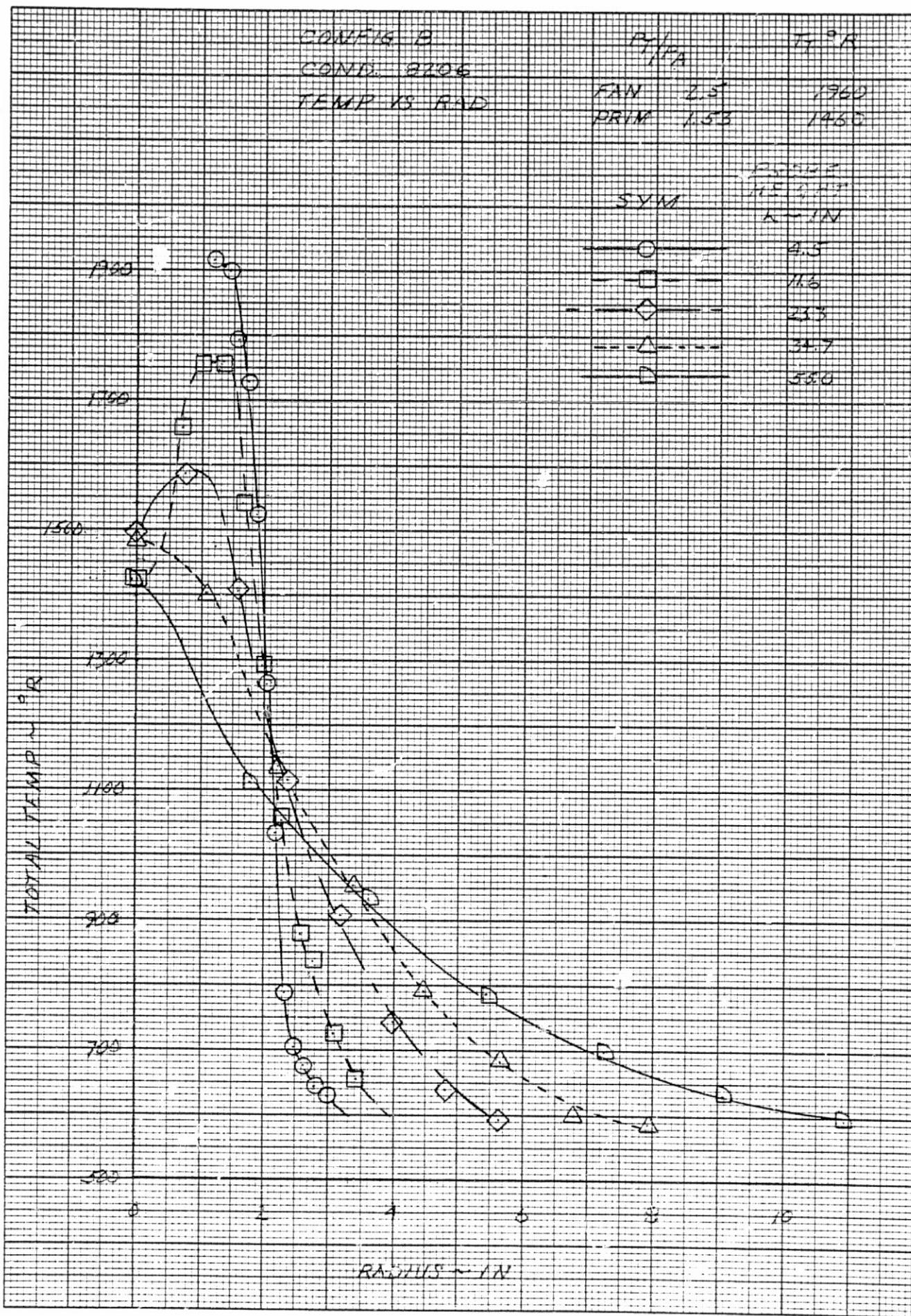




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FEDERATION OF S. A. B. D. B. N.Y.

SQUARE 10 X 10 TO THE HALF INCH AS-0012-01





CONFIG. B
COND 821T

TEMP V.S. RAD.

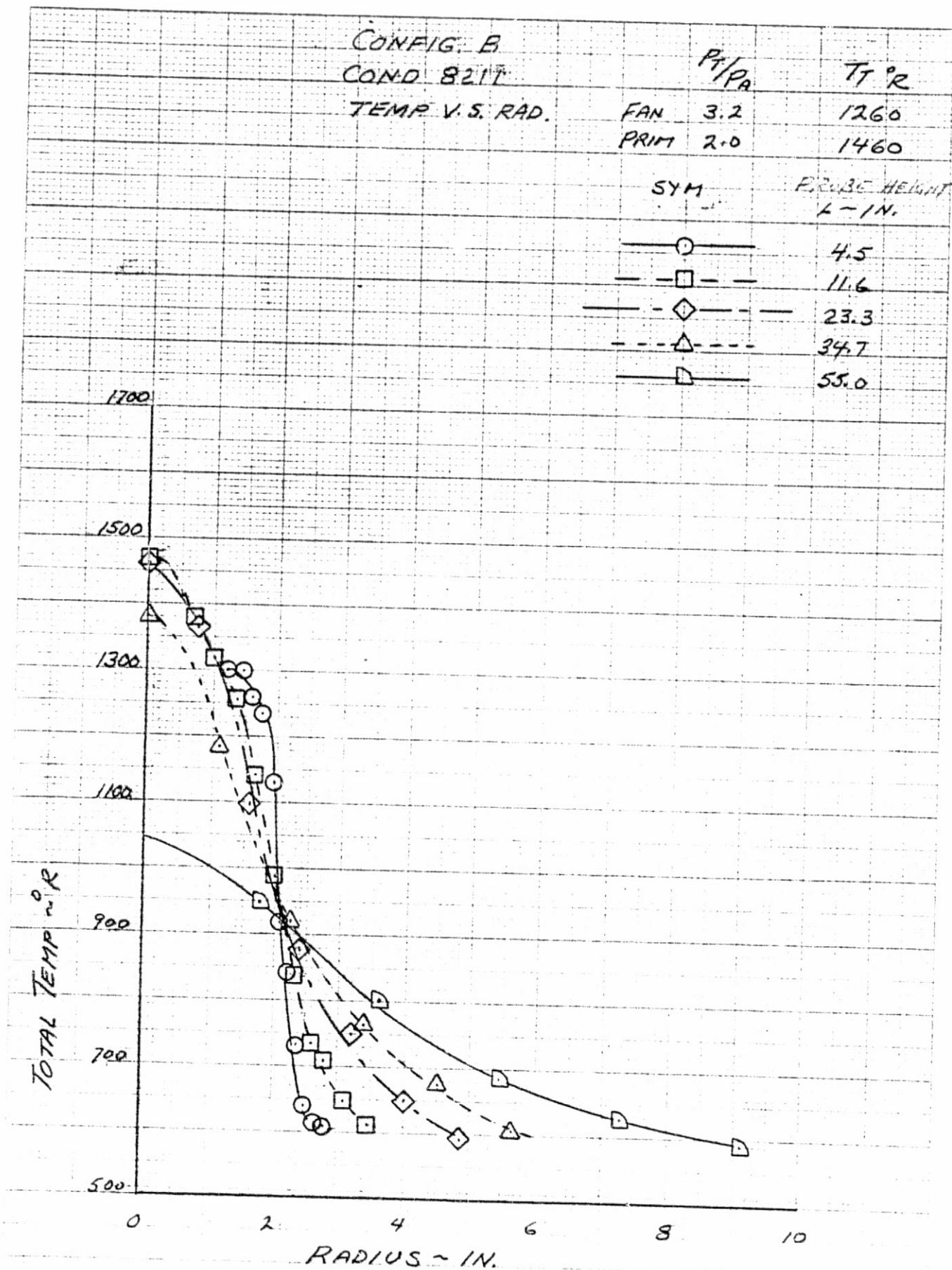
PT/PA
FAN 3.2
PRIM 2.0

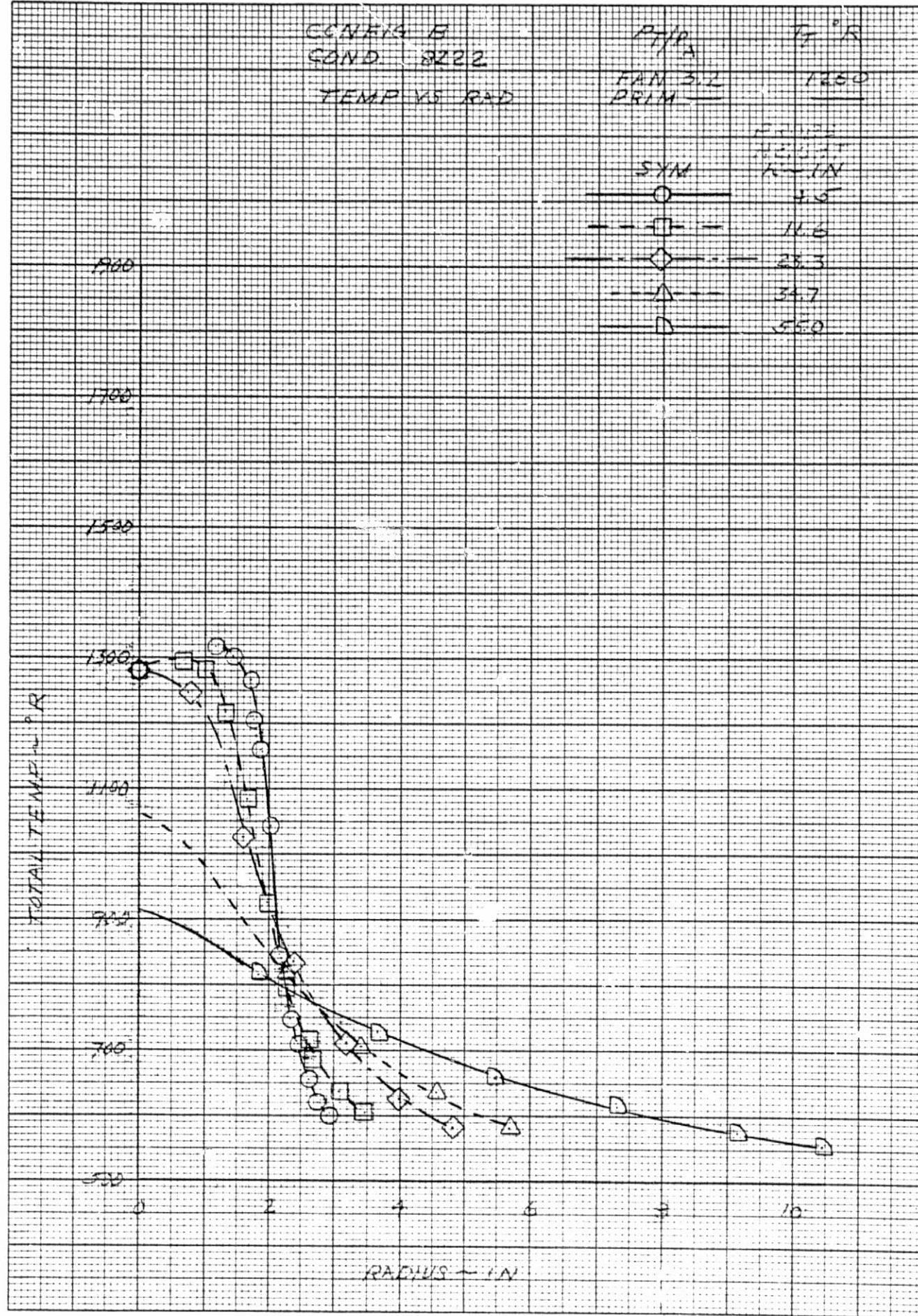
TT R
1260
1460

SYM

FLAME HEIGHT
L - IN.

- - - O - - -	4.5
- - - □ - - -	11.6
- - - ◇ - - -	23.3
- - - △ - - -	34.7
- - - ▽ - - -	55.0



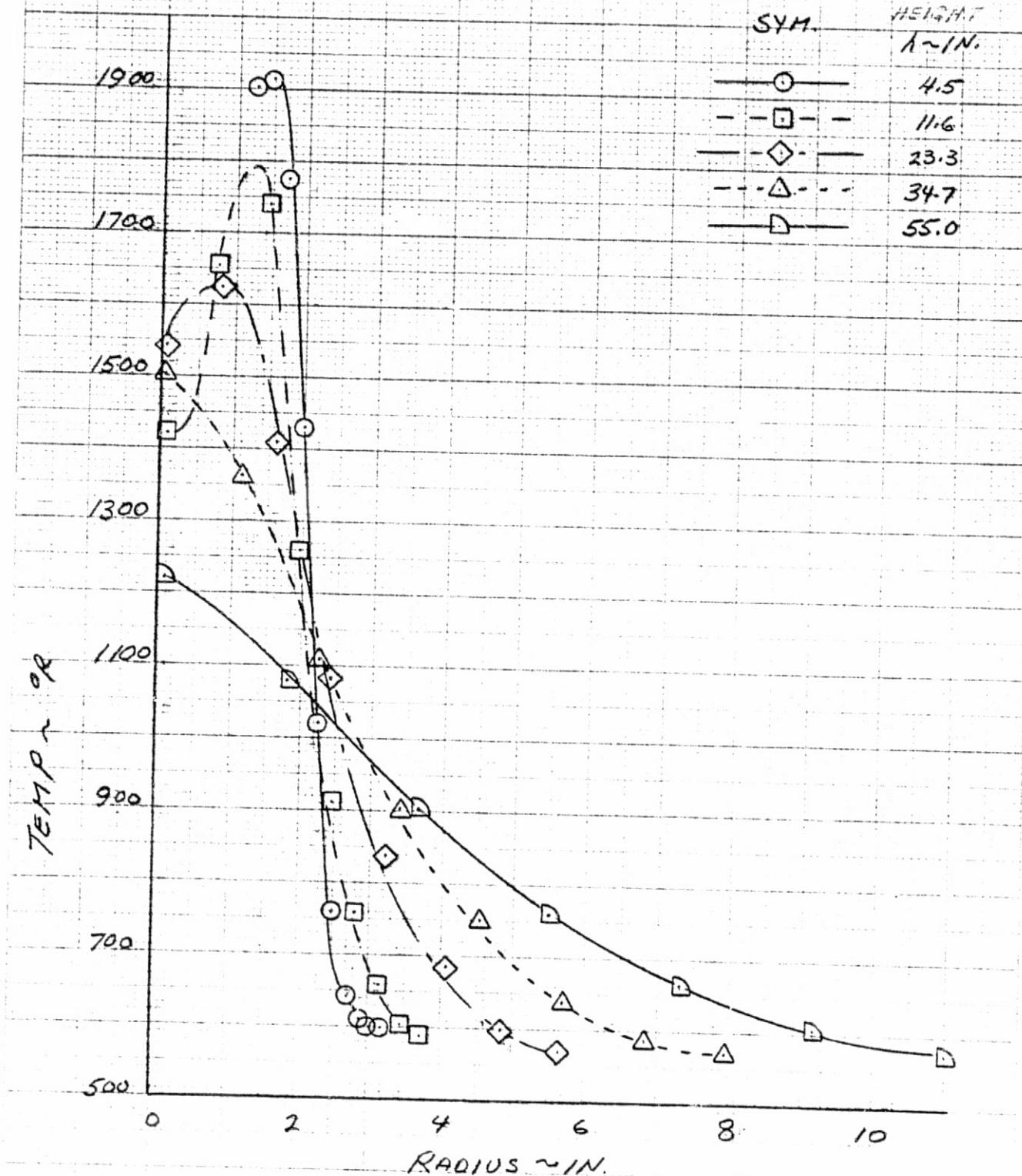


CONFIG. C
COND. 8406
TEMP. VS RAD.

P_1/P_A T_{TOR}
FAN 2.5 1960
PRIM 1.53 1460

PROBE
HELIUM
 $A \sim 1\text{ in.}$

SYM.	4.5
- - - □ - -	11.6
— ◇ —	23.3
— - - △ - -	34.7
— - - □ - -	55.0



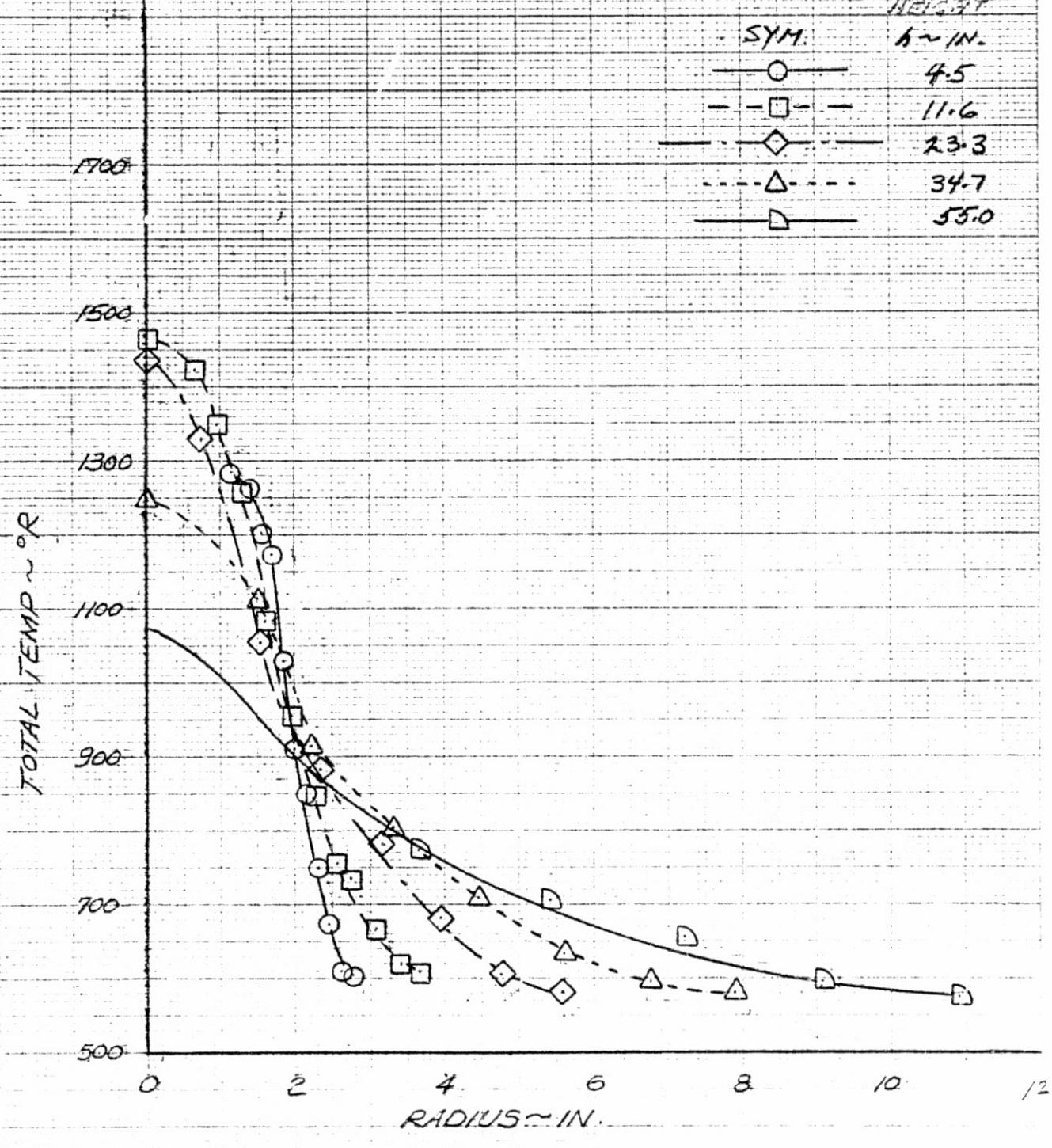
MODEL D
COND 8502
TEMP. VS RAO

P/PR₂ TTR₂
FAN 1.8 1260
PRIM 1.53 1460

PRECISE

HEIGHT

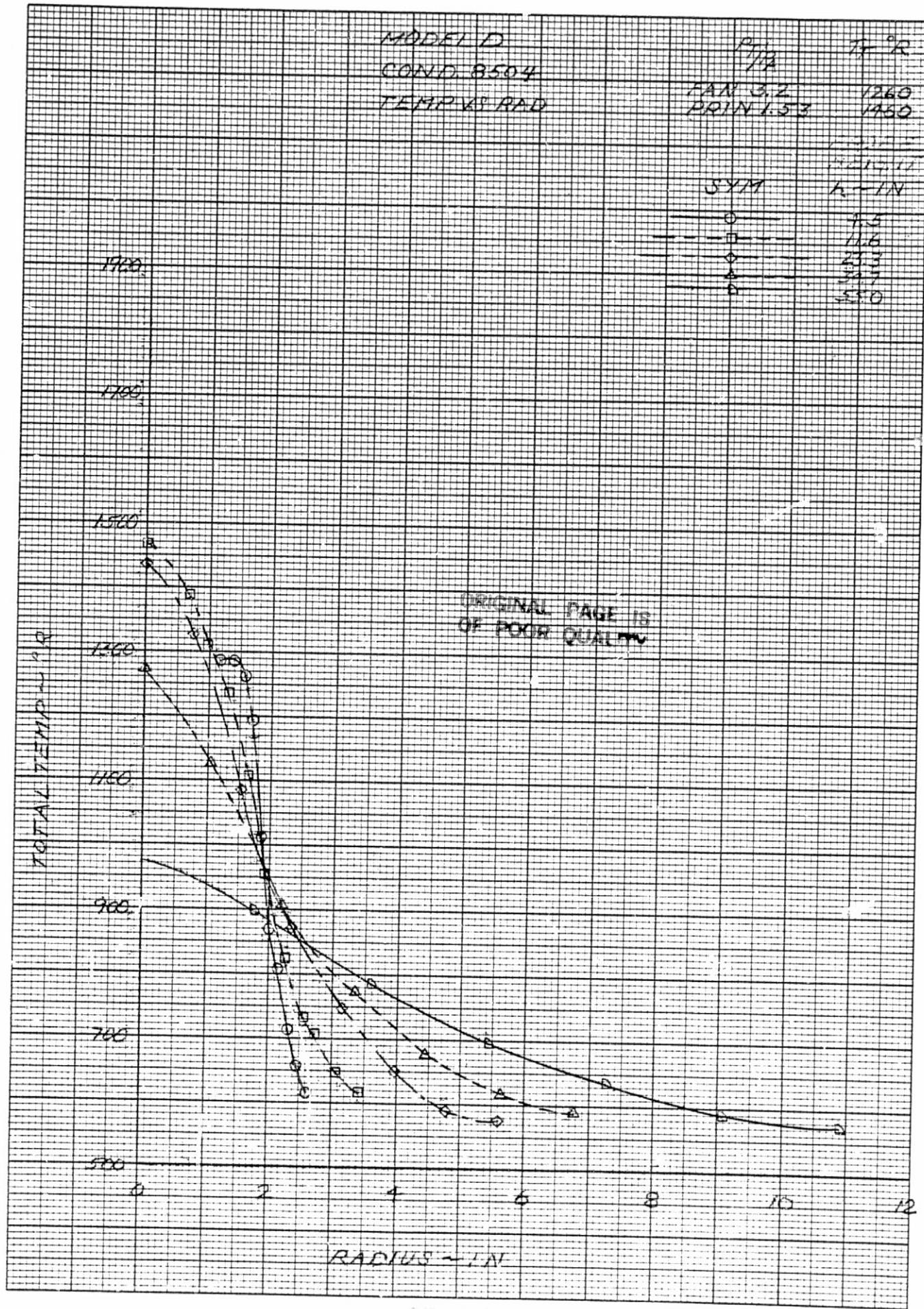
SYM	h~IN.
-○-	4.5
-□-	11.6
-◇-	23.3
-△-	34.7
-□-	55.0

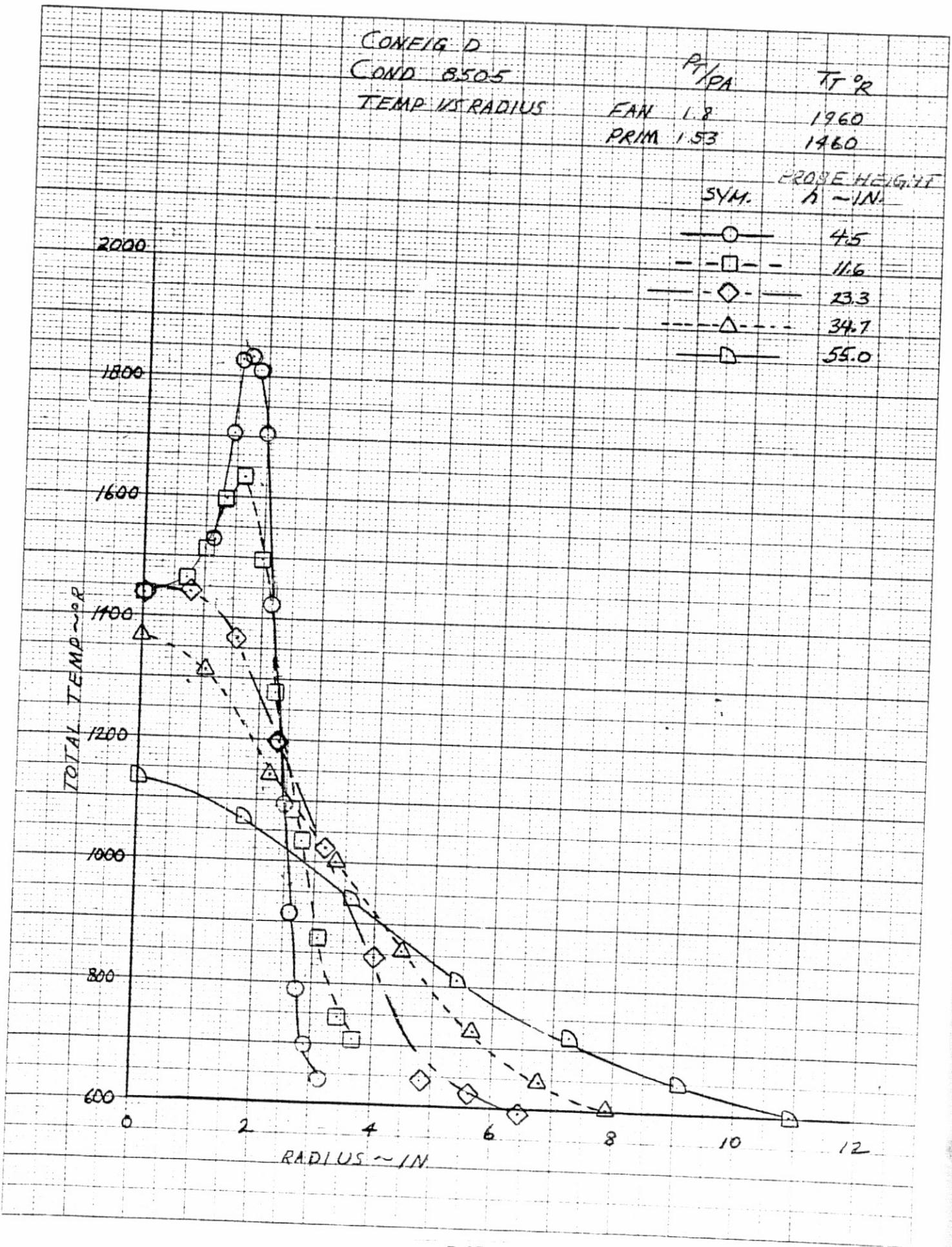


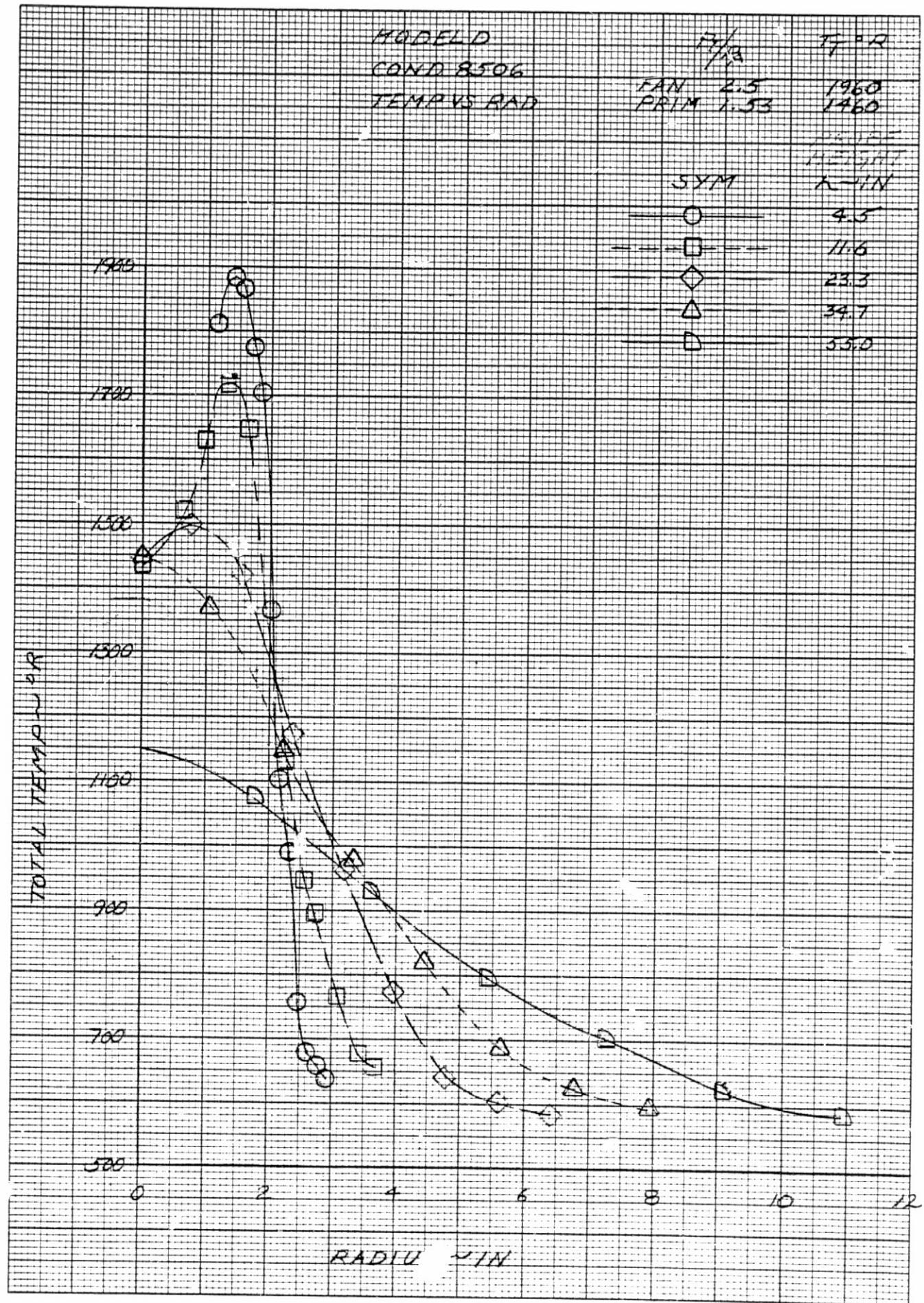
MODEL D
COND. 8504
TEMP AT RAD

P/T 1/14 TR °R
FAN 3.2 1260
PWN 1.53 1450

SYM h-IN
15.5 7.5
15.6 7.6
15.7 7.7
15.8 7.8
15.9 7.9







MODEL D

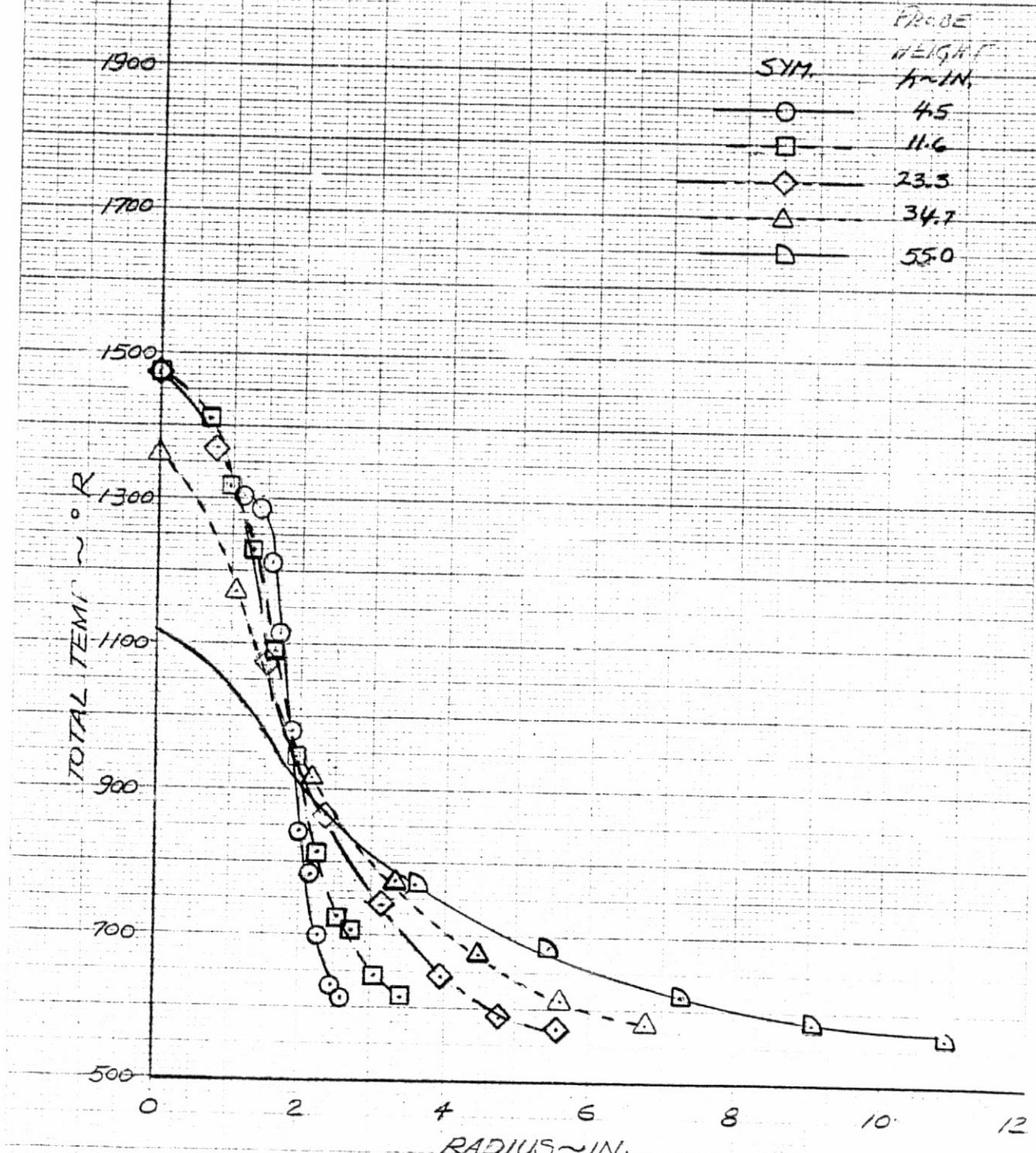
COND. 8511

TEMP. VS RAO.

P/PA T_rR

FAN 3:2 1260

PRIM 2.0 1460



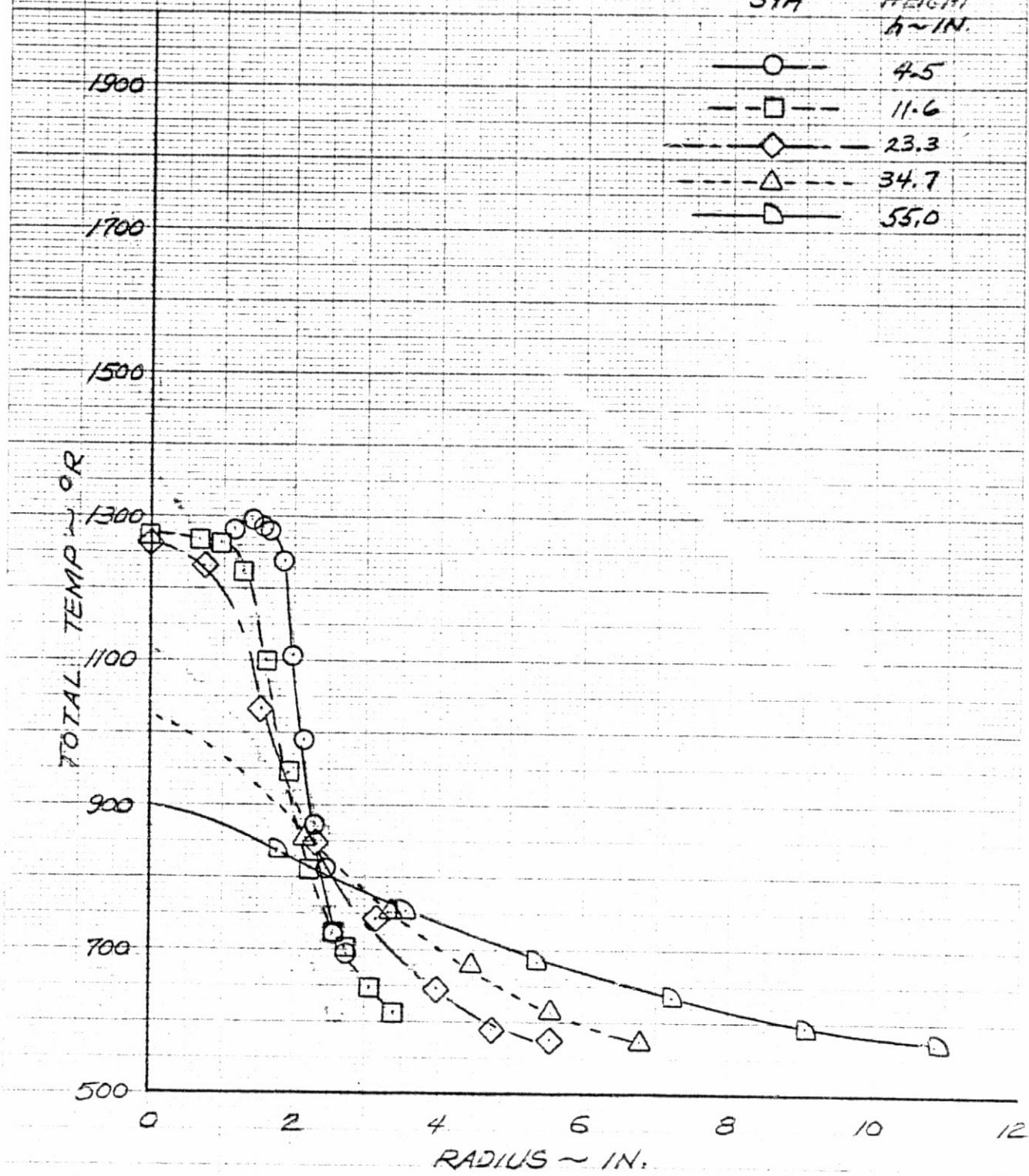
MODEL D
COND 8522

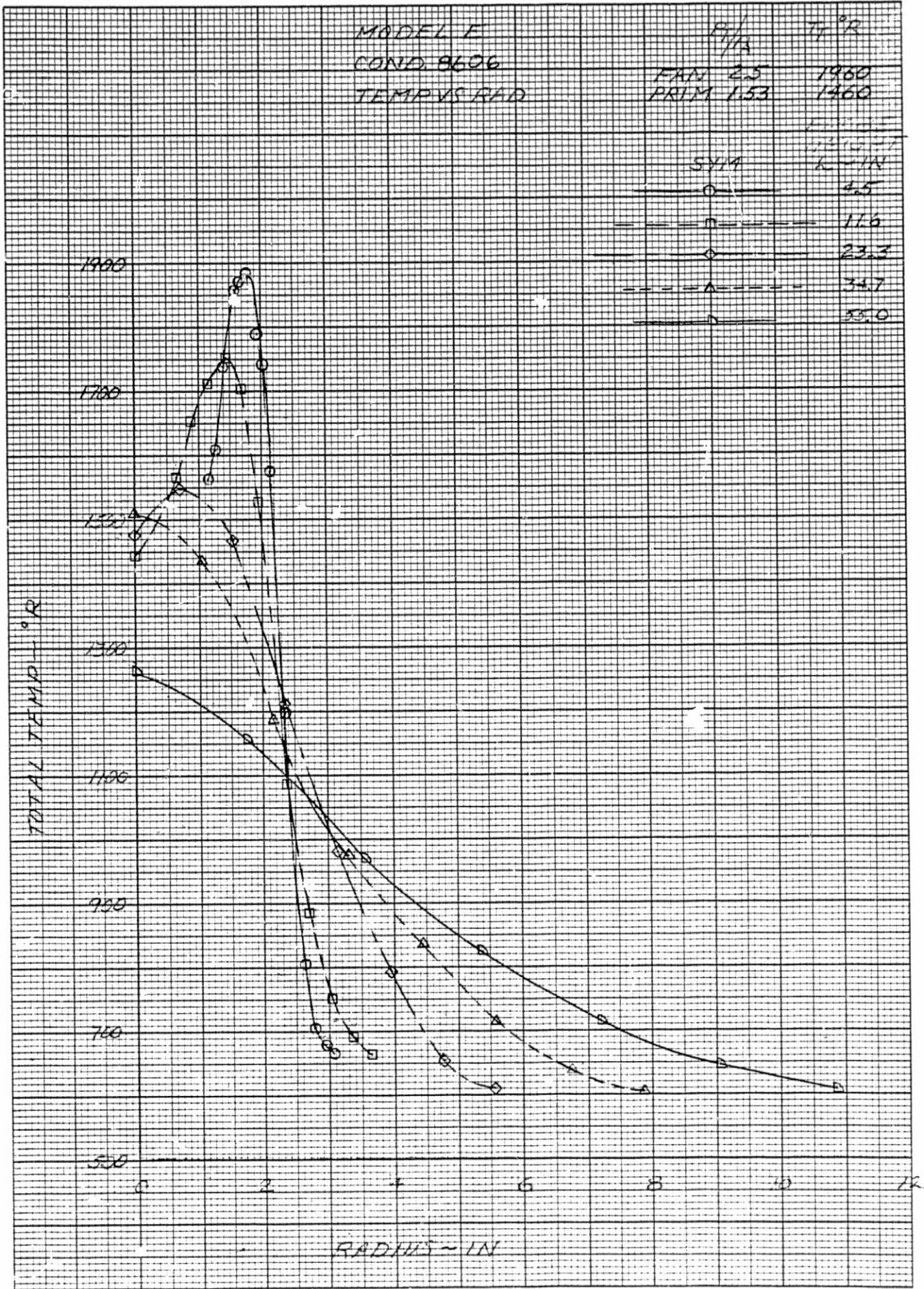
P_T/PA T_T°R
FAN 3.2 1260
PRIM. - -

TEMP VS RAD.

PROBE
HEIGHT
h ~ IN

SYM	4.5
- - - □ - - -	11.6
- - - ◆ - - -	23.3
- - - △ - - -	34.7
- - - ▽ - - -	55.0





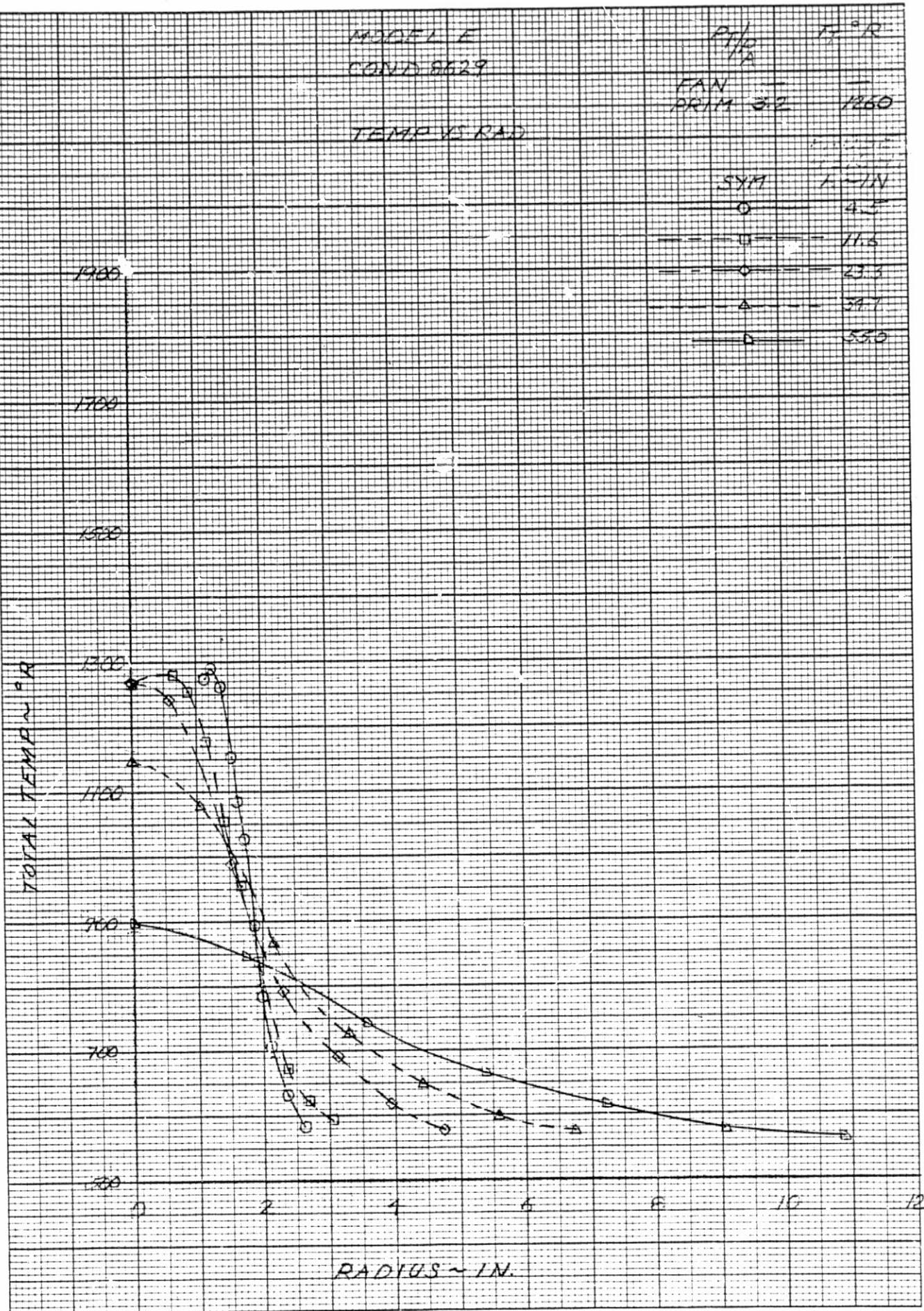
MODEL E
COND 8629

P70
A

T₇ °R

FAN
PRIM 32 1260

TEMP VS RAD



E-1

THRUST COEFFICIENT ~ CT

1.00
0.98
0.96
0.94
0.92
0.90

CONFIGURATION A

$$PNPR = 1.53$$

(8) (8) (8) (8) (8) (8) (8) (8)

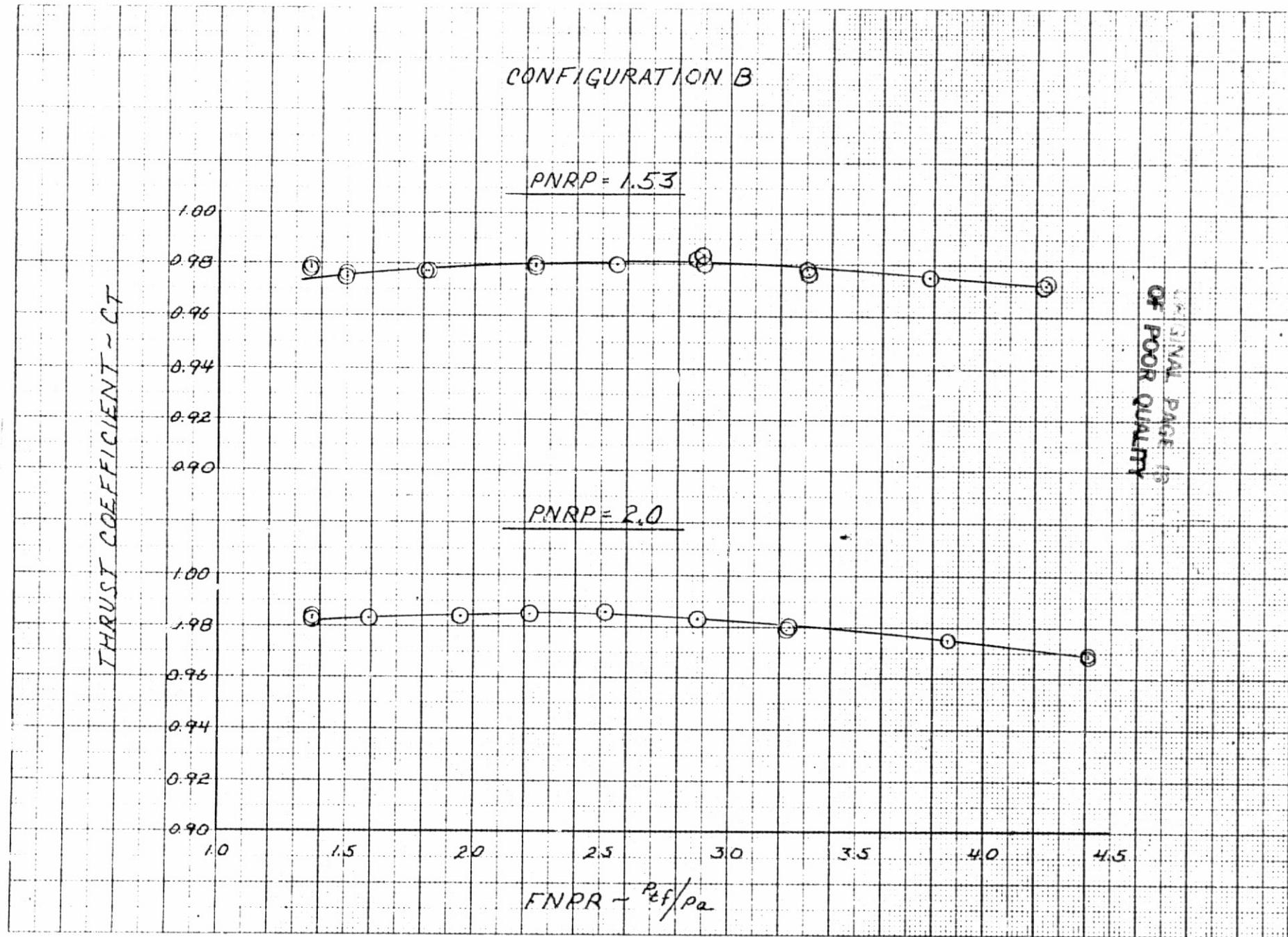
1.00
0.98
0.96
0.94
0.92
0.90

$$PNPR = 2.0$$

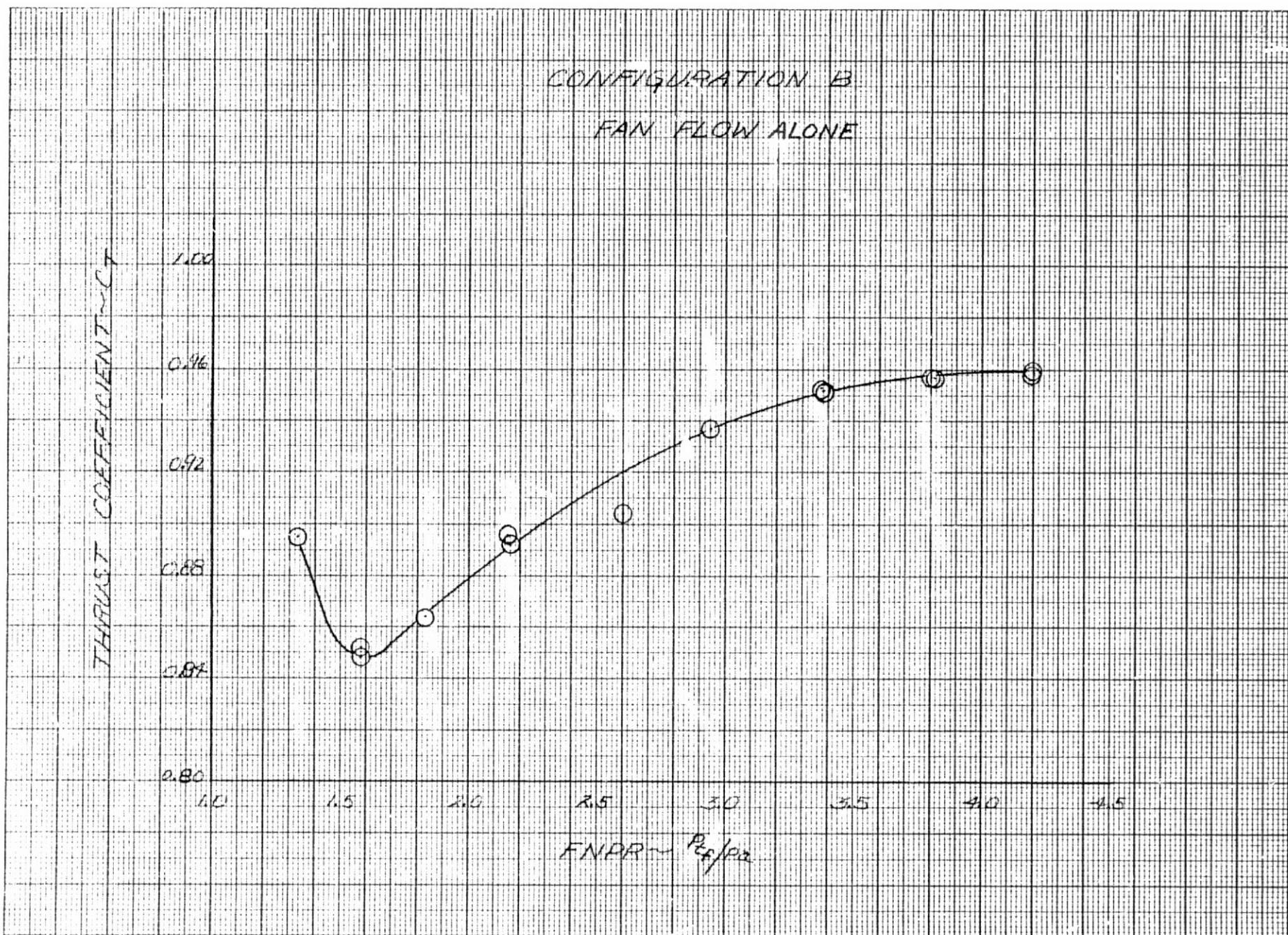
(8) (8) (8) (8) (8) (8) (8) (8)

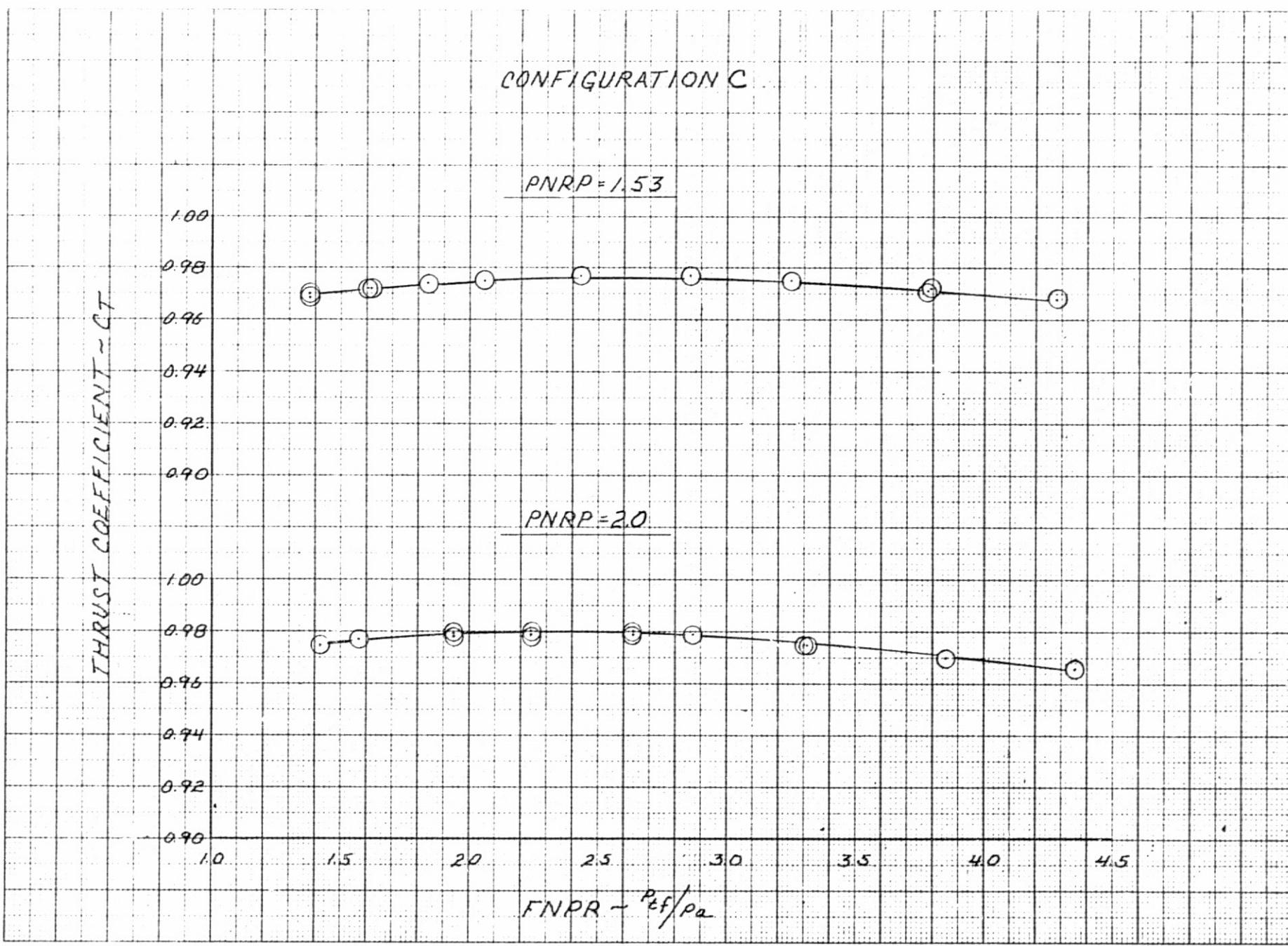
1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

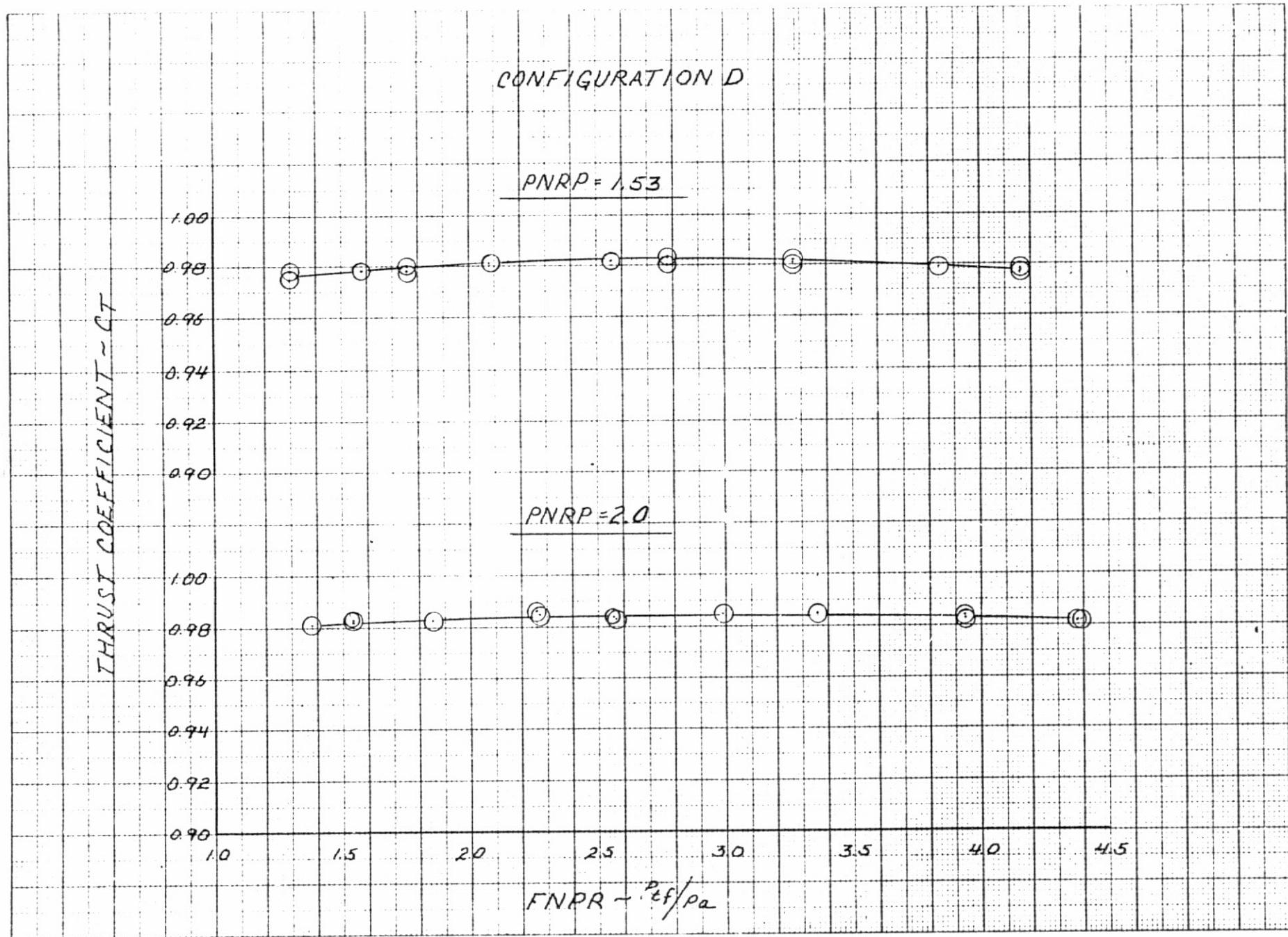
$$FNPR \sim P_{RF}/P_a$$

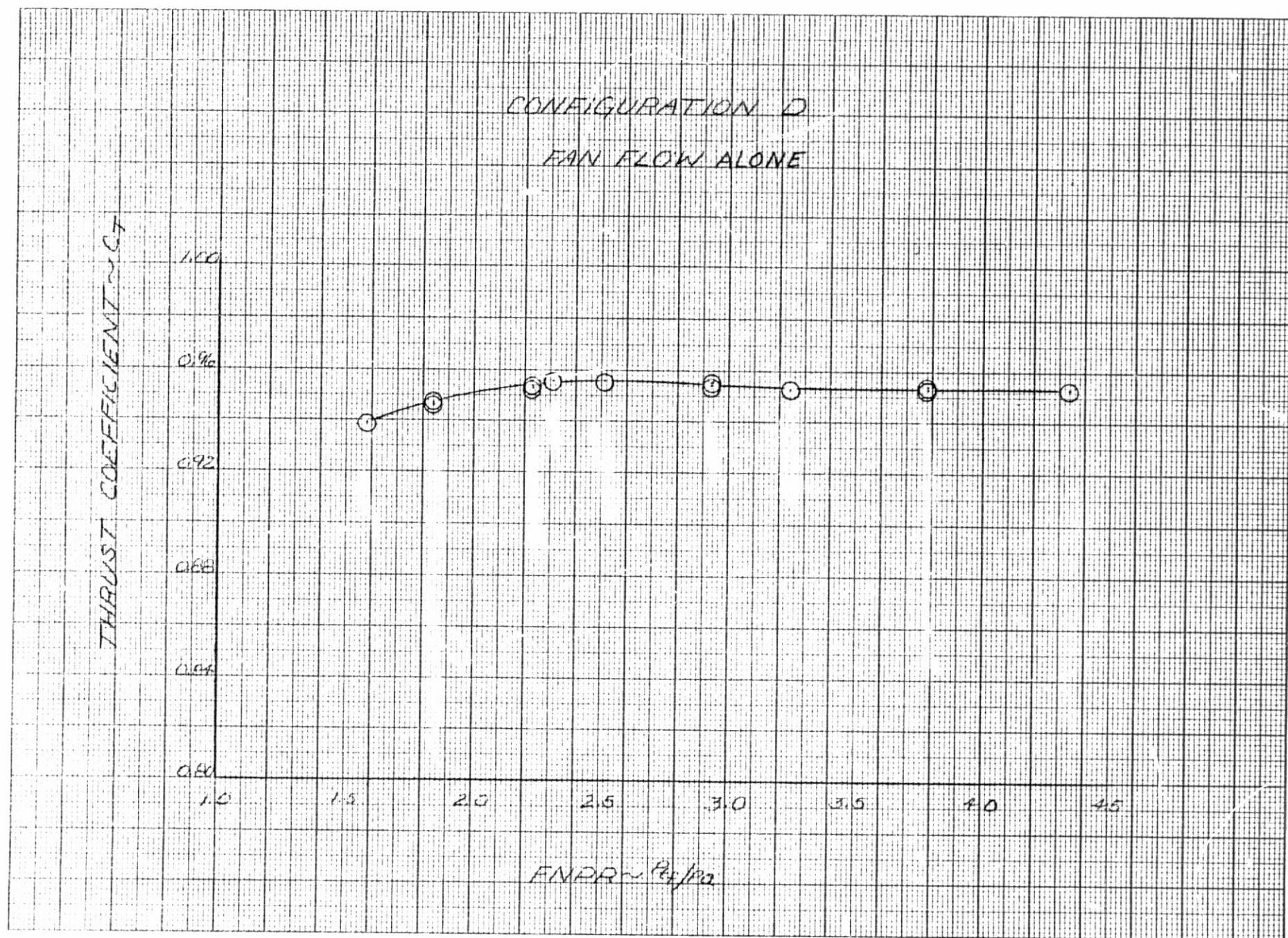


C-4









CONFIGURATION E

THRUST COEFFICIENT - CT

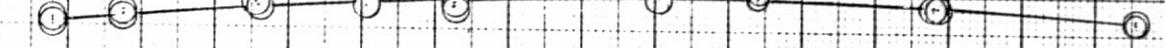
1.00
0.98
0.96
0.94
0.92
0.90

PNRP = 1.53

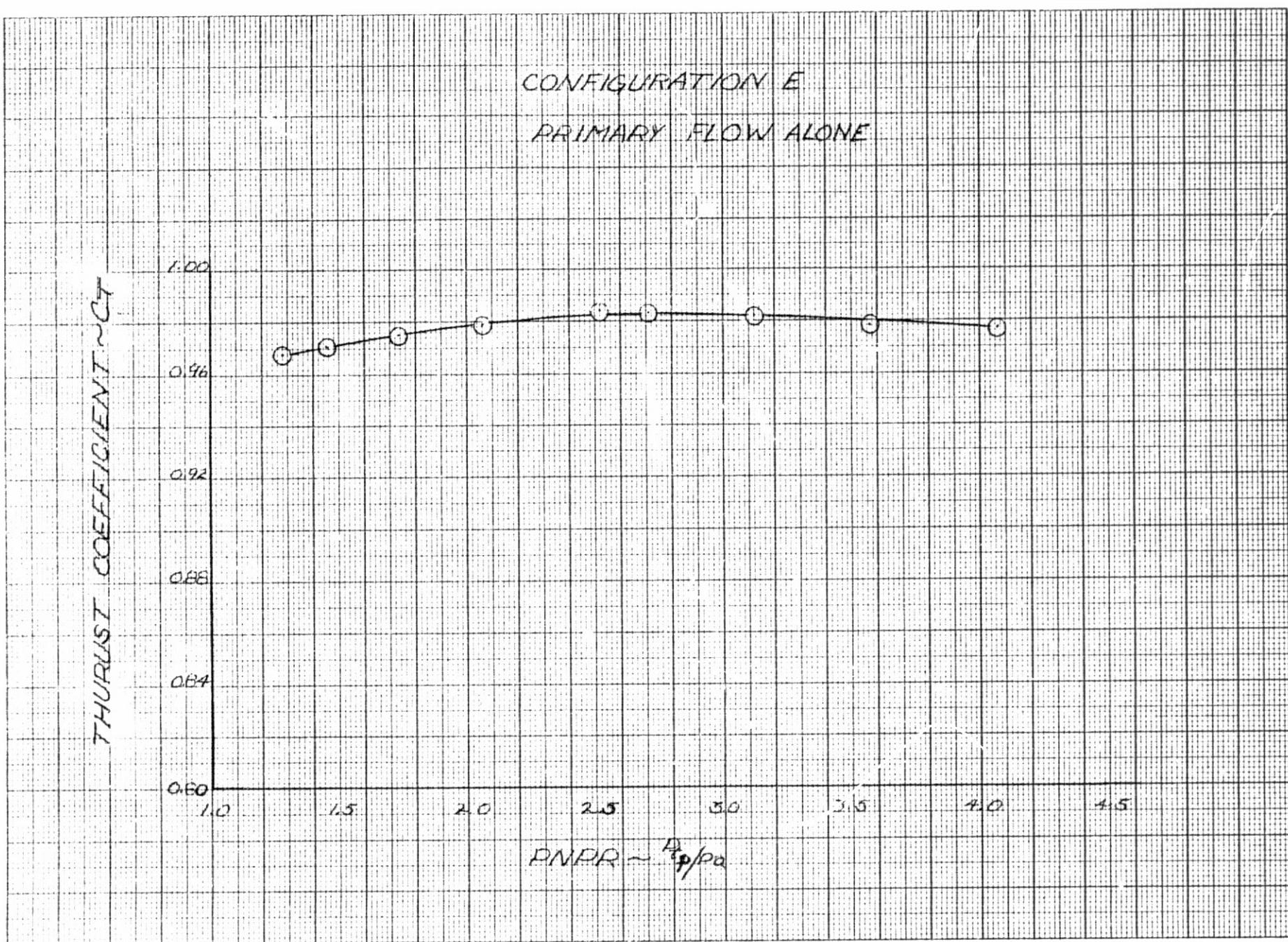


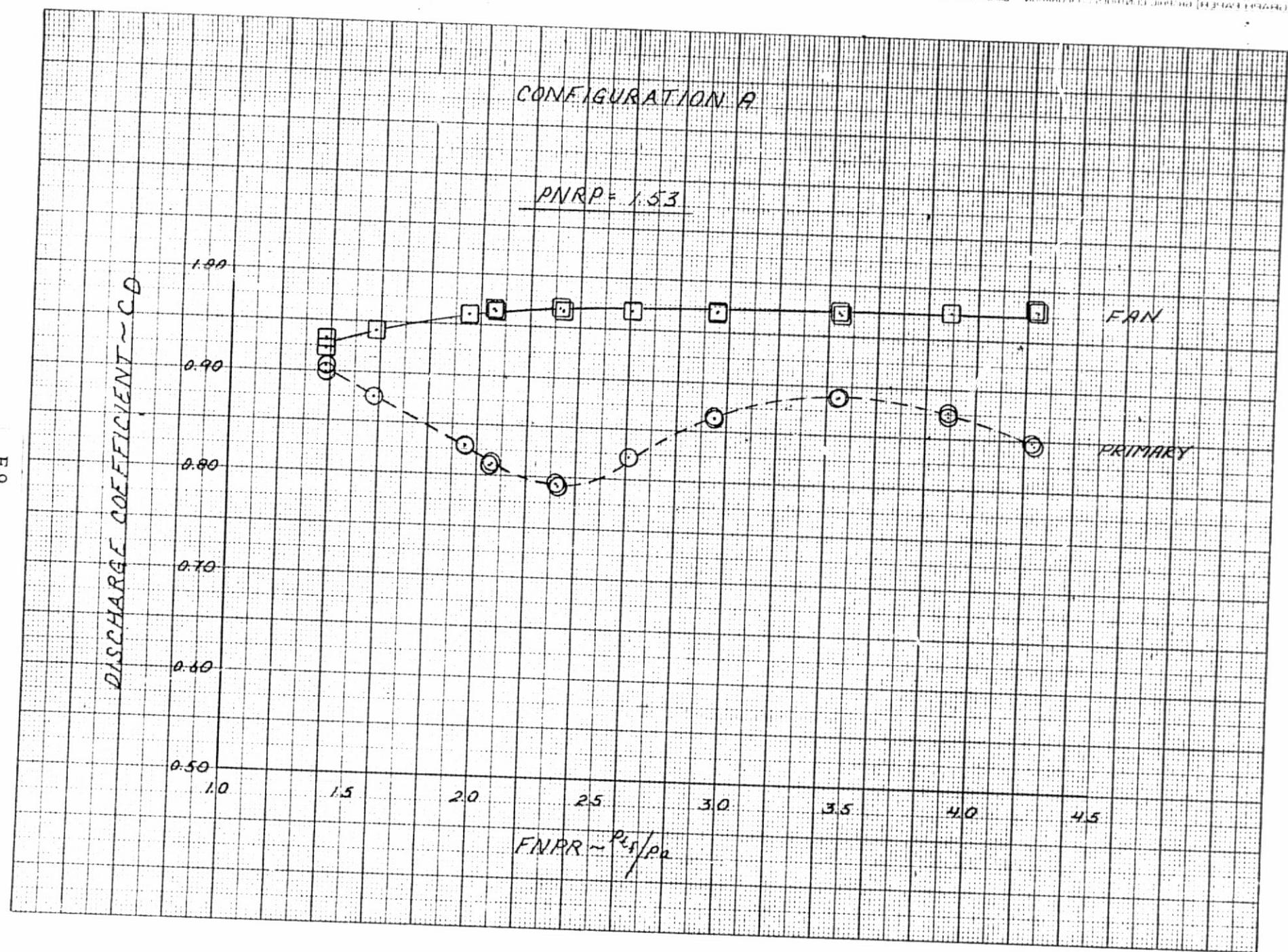
PNRP = 2.0

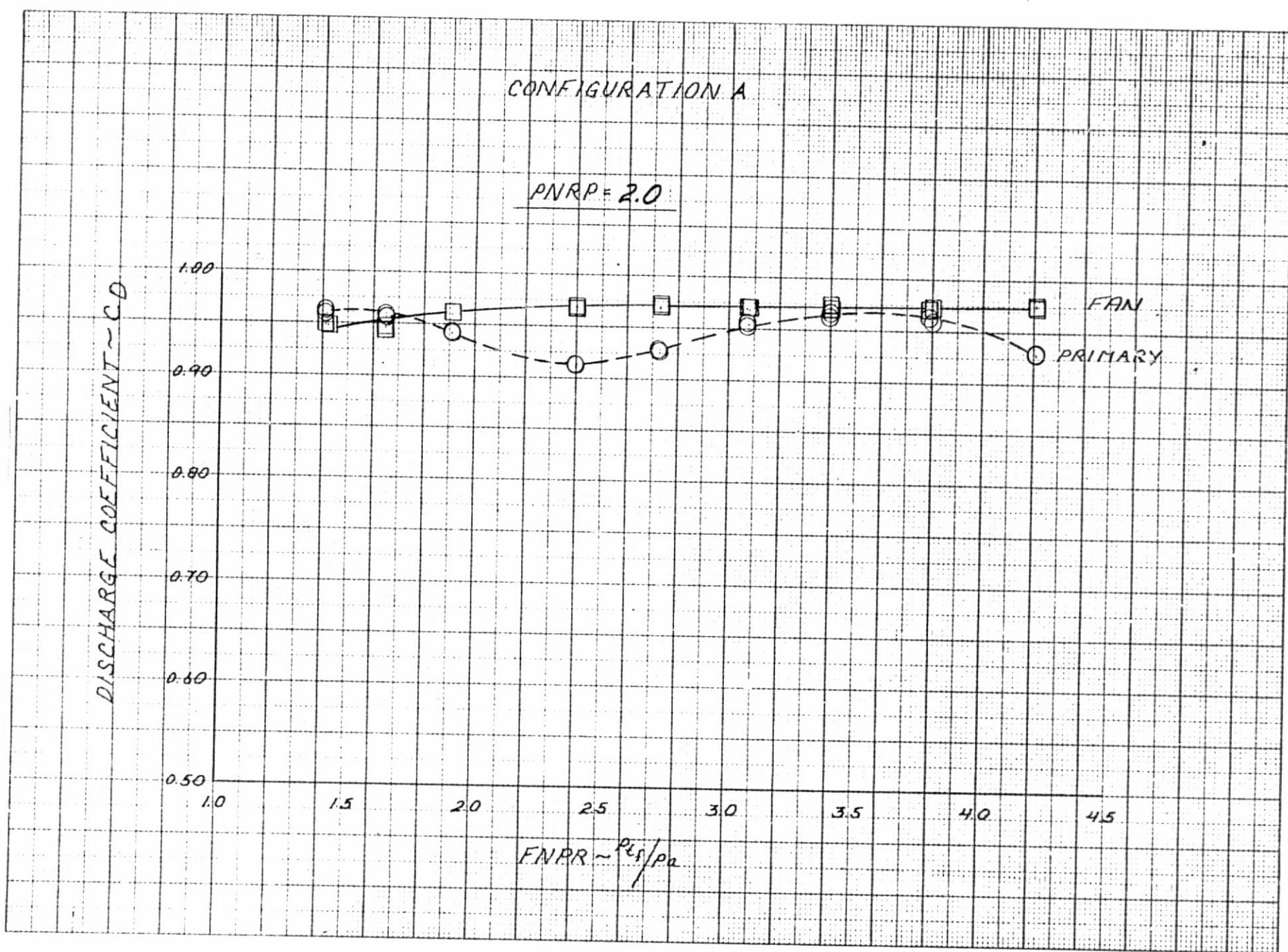
1.00
0.98
0.96
0.94
0.92
0.90



F/NRP = $\frac{P_{ef}}{P_a}$



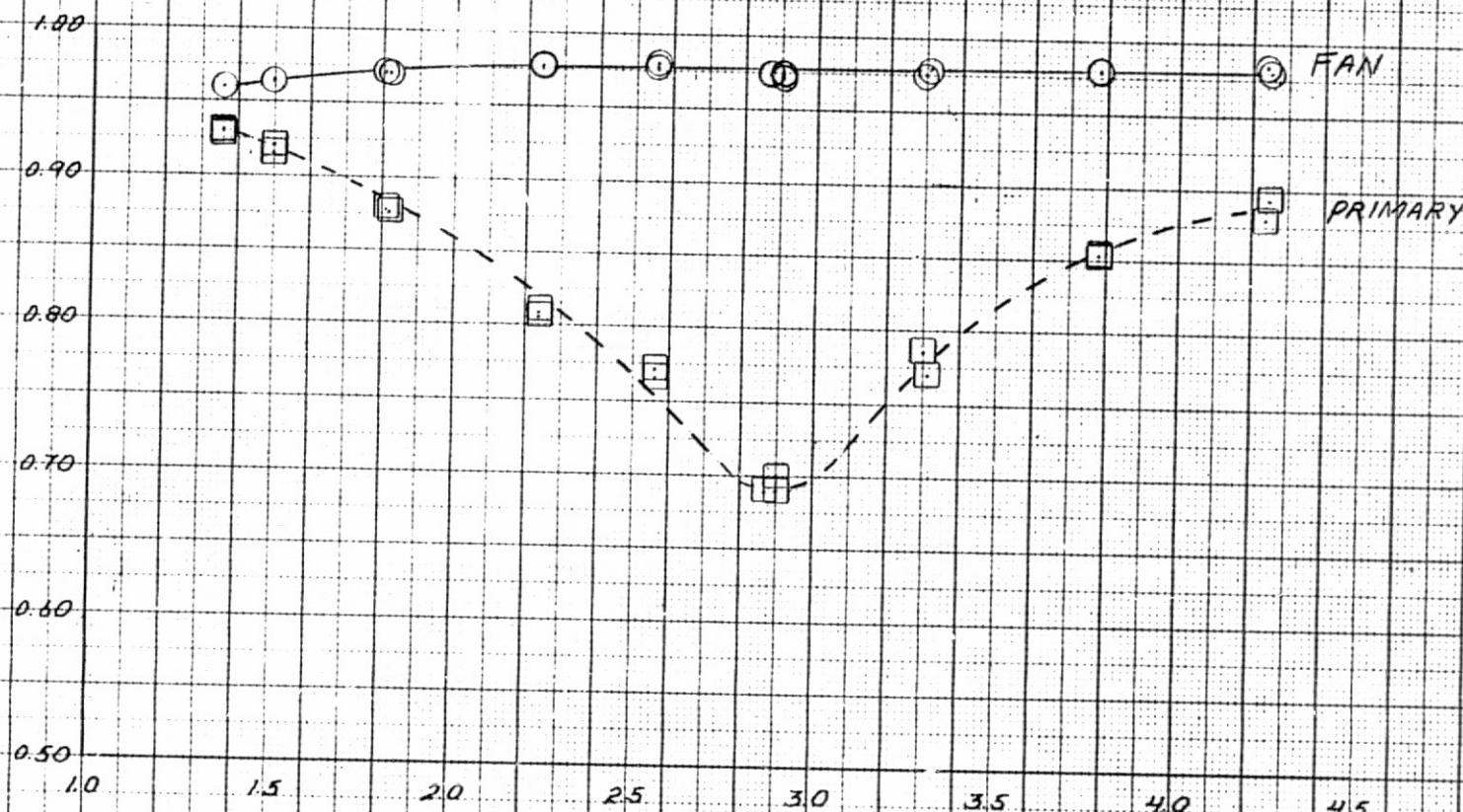




DISCHARGE COEFFICIENT ~ 0.9

CONFIGURATION B

$$PNRP = 1.53$$



$$FNPR \sim \rho_s / \rho_a$$

DISCHARGE COEFFICIENT ~ C_D

CONFIGURATION B

$$PNRP = 2.0$$

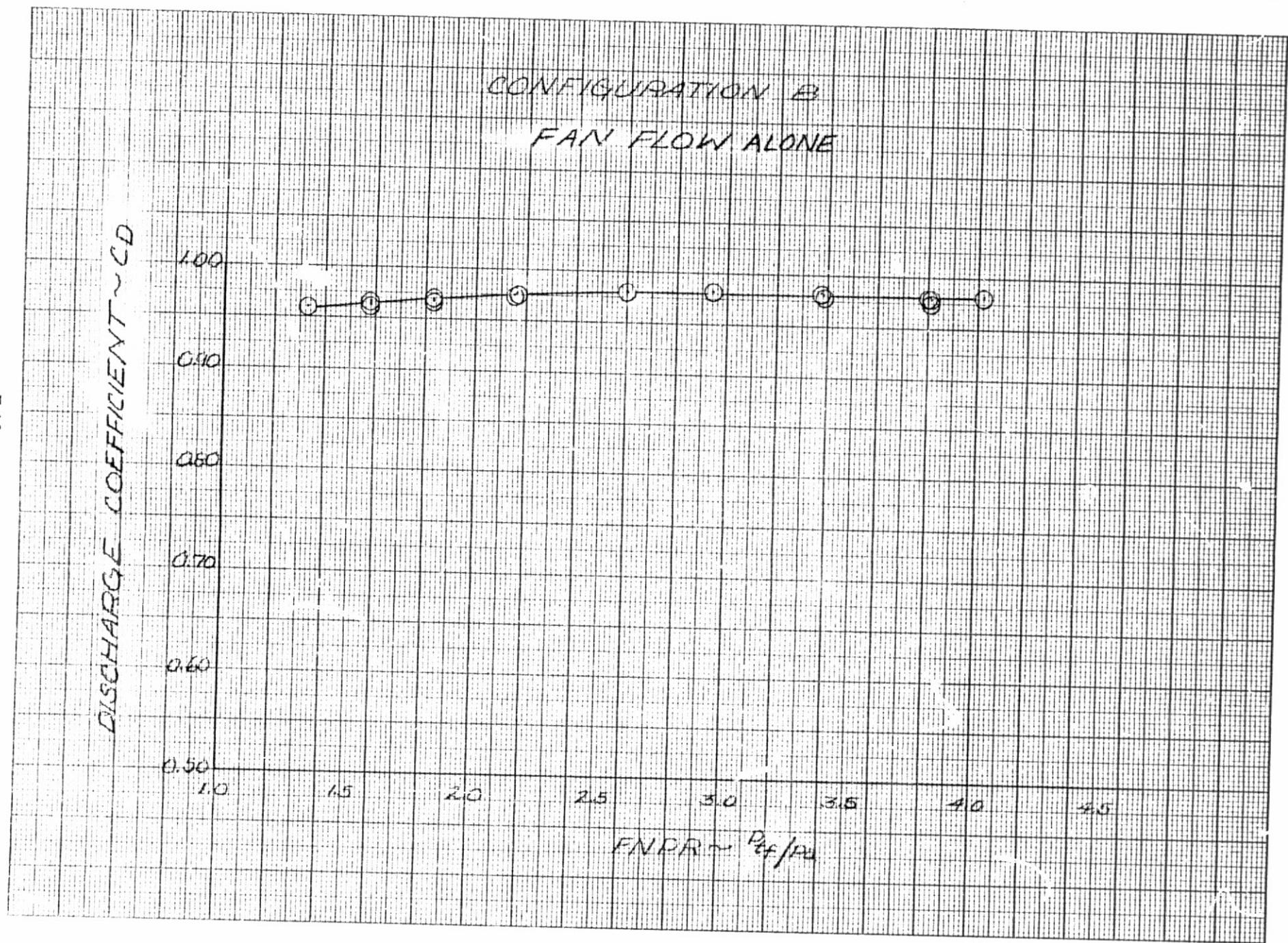
1.00
0.90
0.80
0.70
0.60
0.50

1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

$$FNPR \sim \frac{P_{ex}}{P_a}$$

FAN

PRIMARY



DISCHARGE COEFFICIENT $\sim C_D$

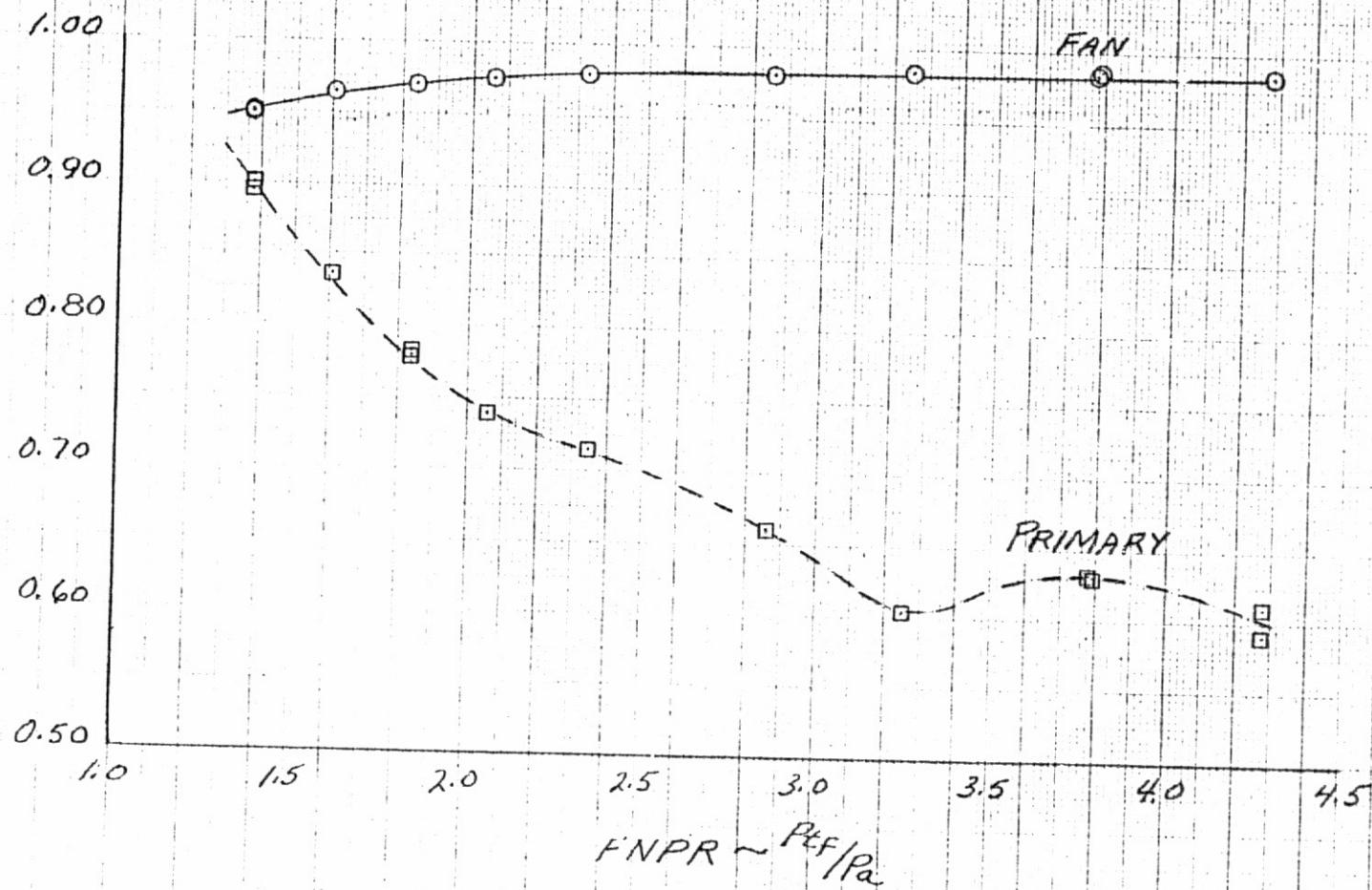
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DC 1910

ORIGINAL PAGE 15
CFS WORKS OUTLINE

CONFIGURATION C

PNPR = 1.53



DISCHARGE COEFFICIENT ~ CD

E-15

CONFIGURATION C

PNRP = 2.0

1.00
0.90
0.80
0.70
0.60
0.50

1.0

1.5

2.0

FNPR ~ ρ_{sf}/ρ_a

2.5

3.0

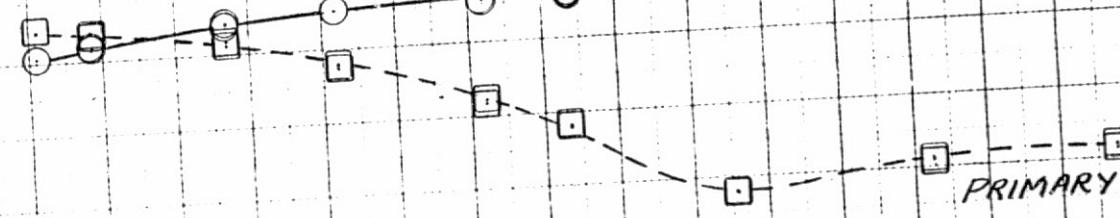
3.5

4.0

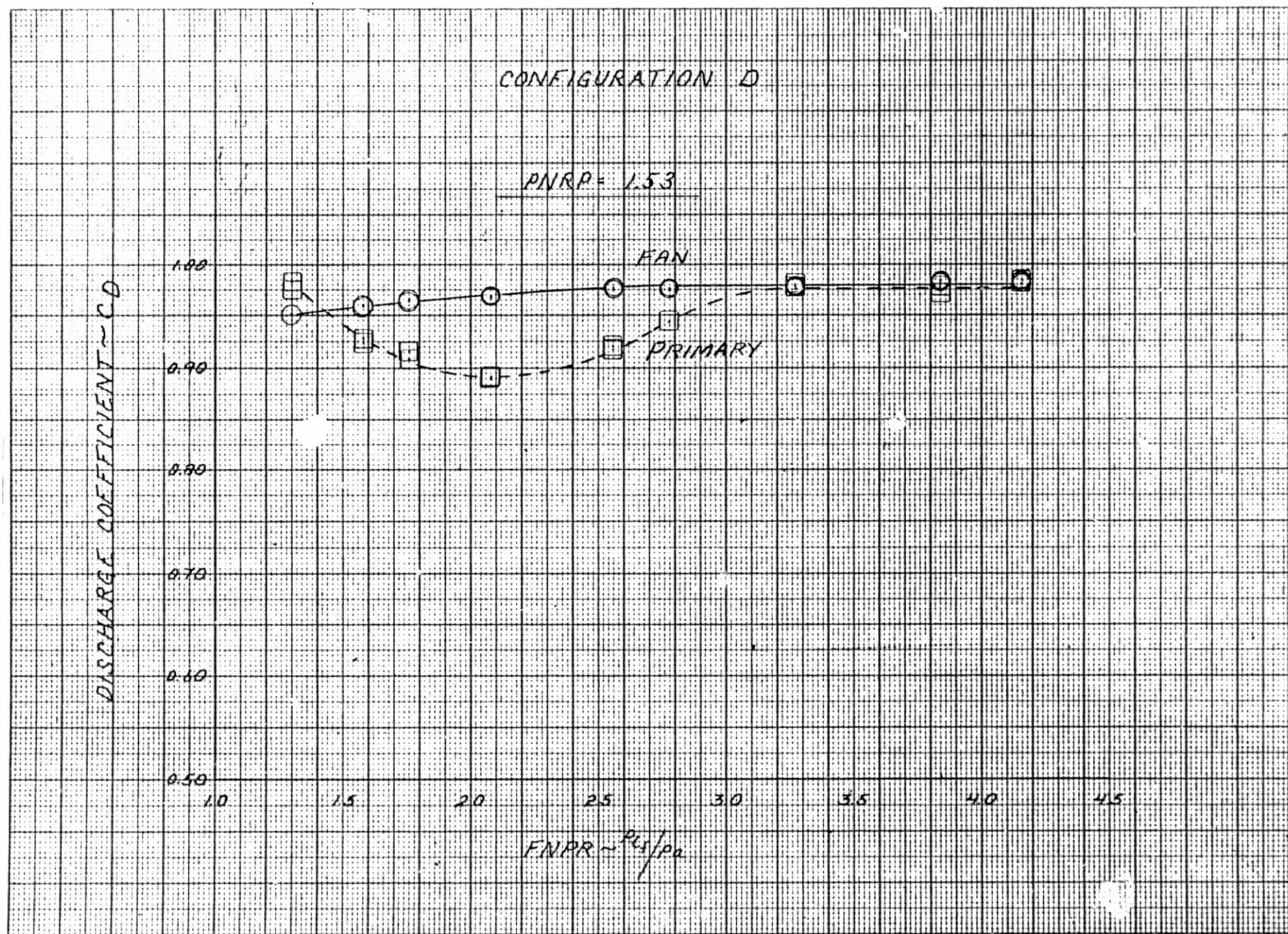
4.5

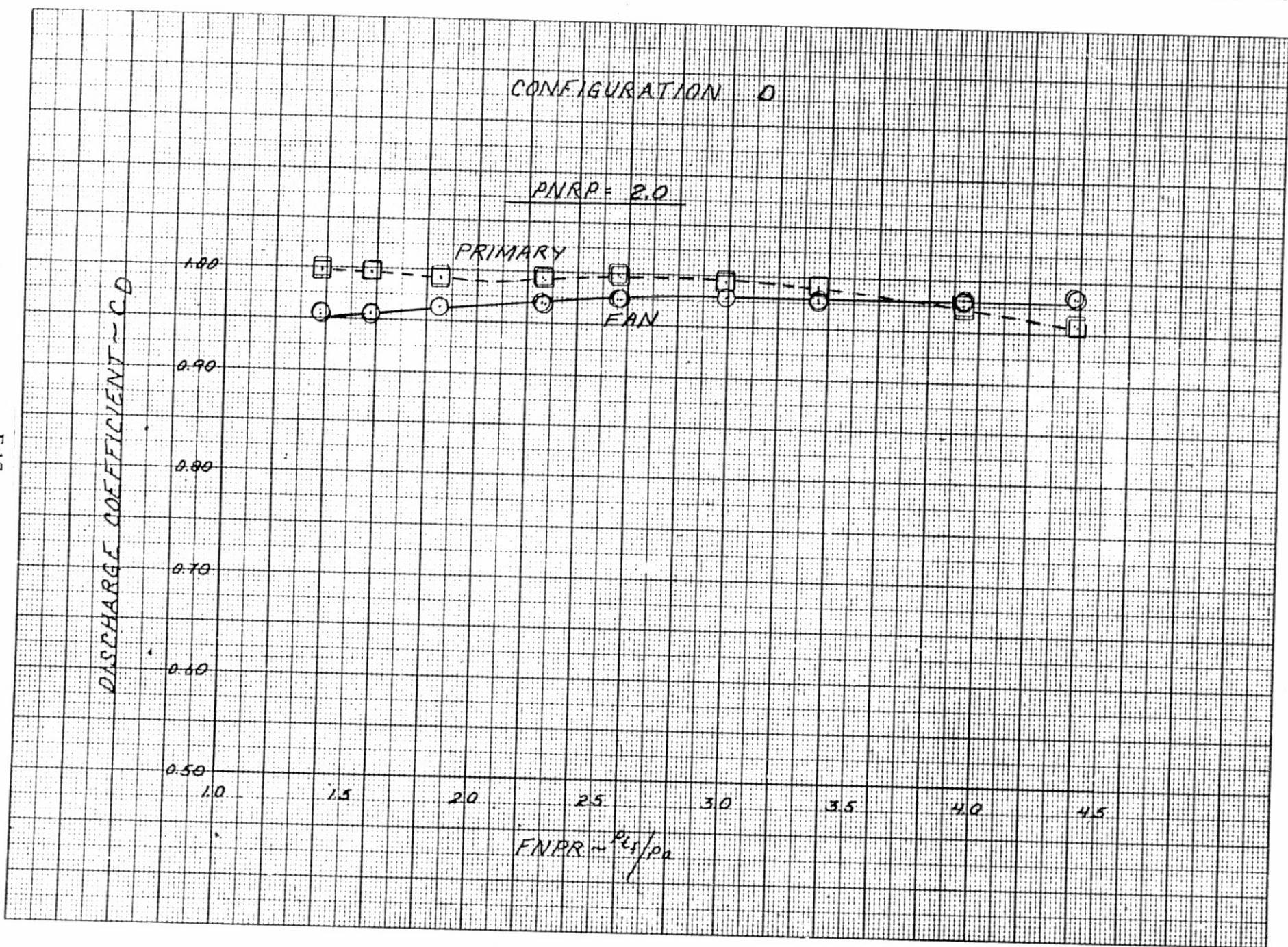
FAN

PRIMARY

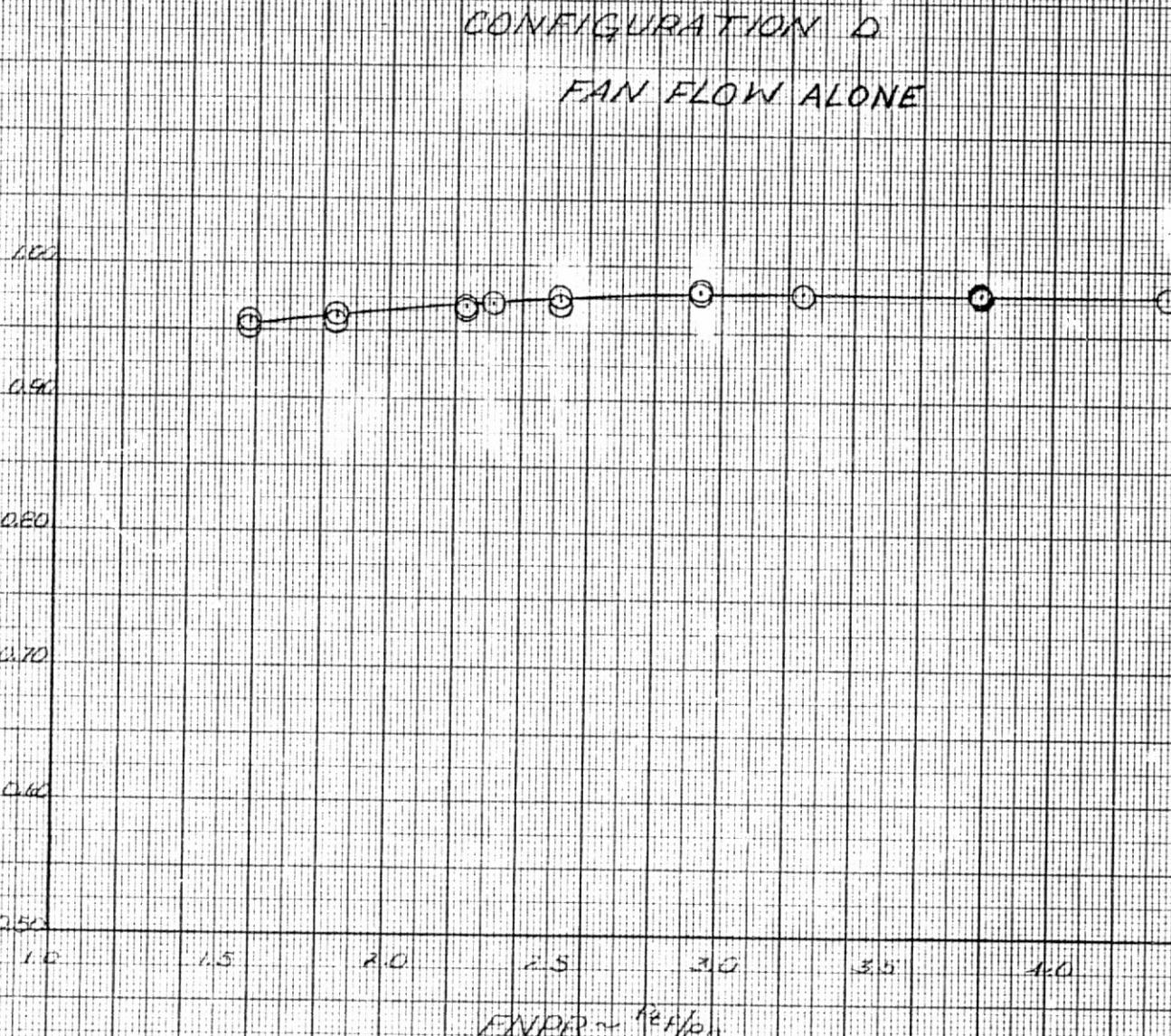


² See also the discussion of the 'new' method of estimation in section 2.2.





DISCHARGE COEFFICIENT ~ C_D

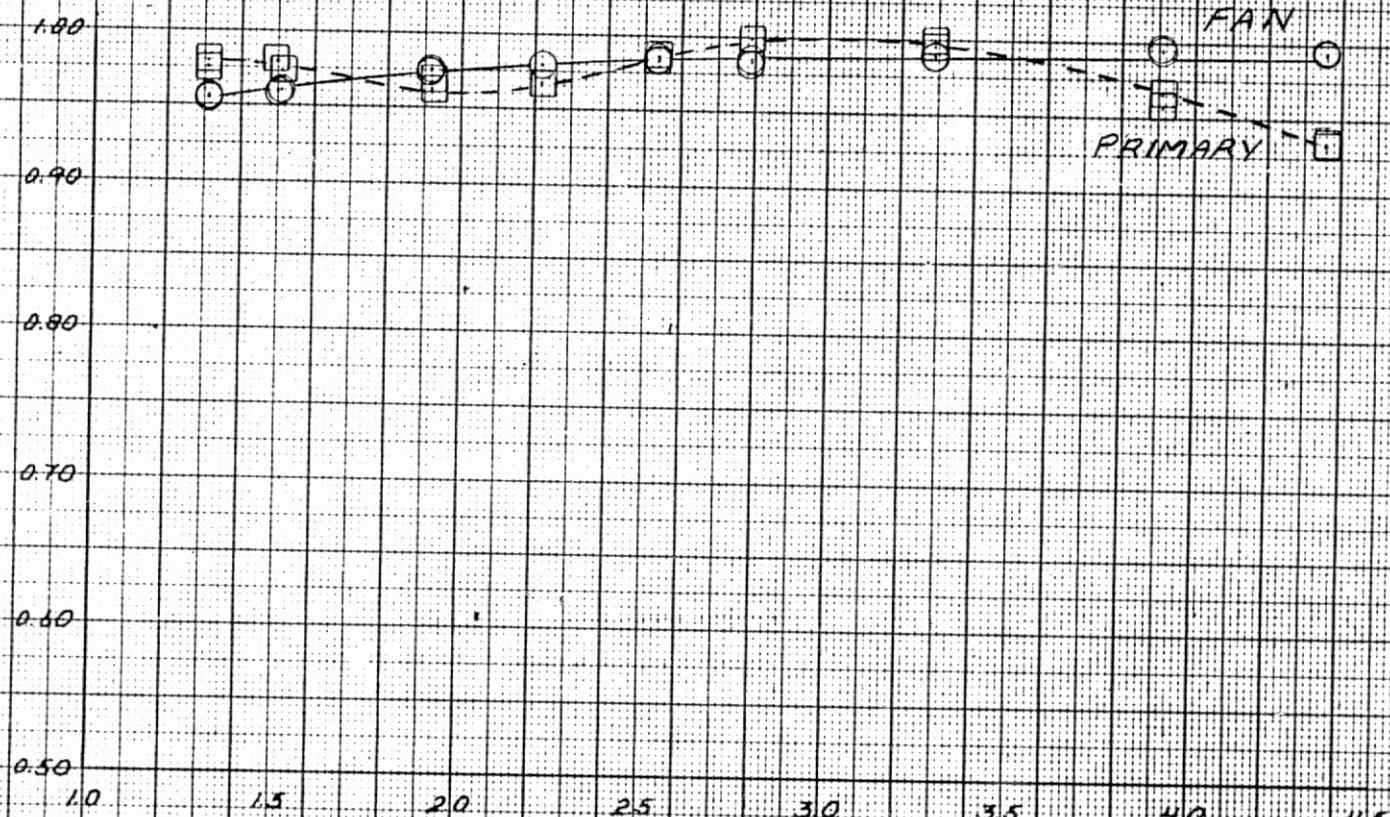


E-19

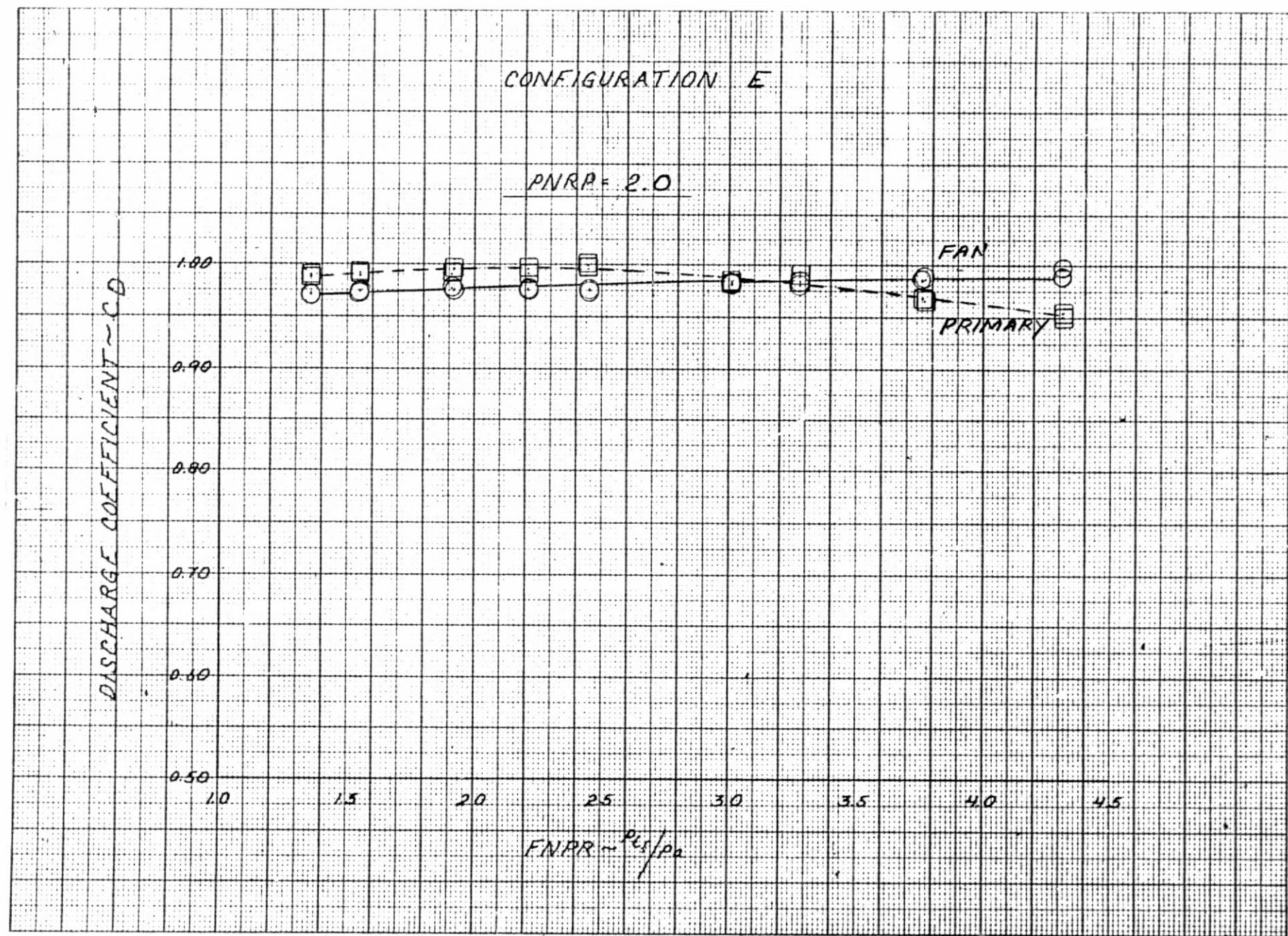
DISCHARGE COEFFICIENT ~ CD

CONFIGURATION E

PNRPA = 153

FNRPA ~ P_{fan}/P_{pa}

E-20



E-21 DISCHARGE COEFFICIENTS

CONFIGURATION E
PRIMARY FLOW ALONE



$P_{npr} \sim P_p/P_a$